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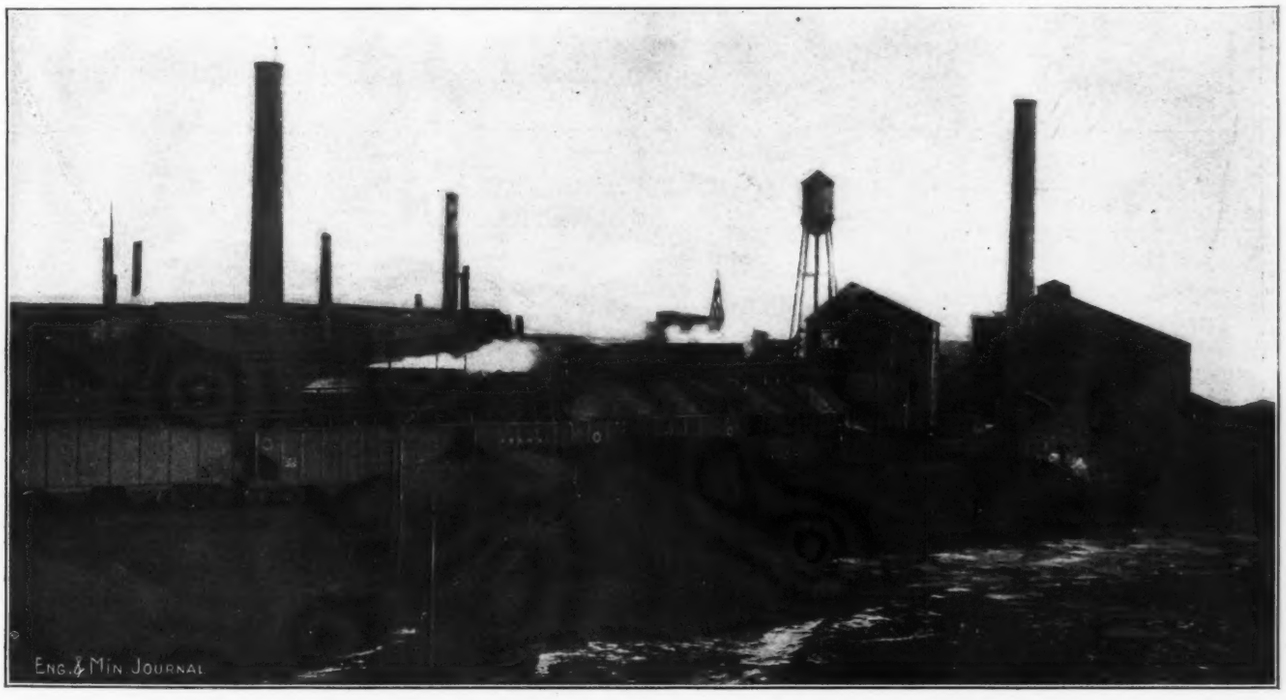
The Copper Smeltery of the U. S. Metals Refining Co.

By Richard H. Vail

The copper-smelting plant of the U. S. Metals Refining Co., at Chrome, N. J., was built in 1907 and comprises two blast furnaces, 44x186 in., and two stands of converters that were originally operated with acid lining, but since 1911, magnesite brick has been used under license from Peirce & Smith.

The plant is situated on deep water in New York harbor and on account of this position is able to secure its ore supply from distant sources such as South America, Cuba, Spain and other over-sea points. Ores are received both by rail and water but by far the larger proportion comes by water. On account of the variety of the ore supply, the smelting conditions are unusual, and while the plant is not a large one, as smelting plants go nowadays, it is of especial interest by reason of the metallurgical conditions imposed. Perhaps the two points of most interest are: (1) An experiment that is being conducted to dispose of flue dust by nodulizing in an ordinary 6x60-ft. cement kiln; and, (2) the use of a ferrosilicate slag, with practically no lime. Iron-bearing material is so abundant that it has been decided to be more economical to make ferrosilicate slag than to smelt barren limestone as a flux—a condition that does not prevail at many custom smelting plants.

The smeltery adjoins the copper refinery of the U. S. Metals Refining Co., and was built as a consequence of frequent offerings of ore received. While the smelting plant forms a convenient outlet for refinery slag and other byproducts, it is operated as a distinct department, though, of course, under the general supervision of the works' manager, Lawrence Addicks. The smelting operations are under the direct charge of R. M. Draper, formerly of the Boston & Montana smeltery at Great Falls. The plant is operated in 8-hr. shifts and, exclusive of unloading and general yard work, employs from 85 to 100 men, depending on whether one or two furnaces are in blast.



Smeltery of the U. S. Metals Refining Co., Chrome, N. J.

Construction of the plant was begun late in 1906, and the first furnace was blown in during Sept., 1907. On account of variety of the ores that were offered when the construction of the plant was being considered, it was originally laid out with a bedding system for the ores. This has not been found necessary in actual practice. By grouping the ores as received and by watching the furnace operation closely, there is little interruption in the smelting campaign from abrupt changes in the composition of the slag.

The smelting charge consists mainly of: (1) Oxides and carbonates from South America and Cuba; (2) pyritic ores from Spain and Canada; (3) pyrites cinder; (4) Cobalt silver ores, not exceeding 300 oz. in silver; (5) custom mattes; (6) refinery byproducts, consisting mainly of slag and cobbing from furnace repairing. In addition, there are the usual cleanup materials from the smelting and converting operations, and the flue-dust nodules from the nodulizing kiln.

The South American and other over-sea ores are delivered by steamer at the works' dock shown in the accompanying engraving. These are then shoveled into buckets and dumped into cars, or, if sacked, are hoisted in a sling by one of the steamer winches and delivered in bunches of 10 to a platform over a railroad car. The platform, which is set loosely on the railroad car, has a slot about a foot wide running lengthwise, and on cutting the sewing in the mouth of the sacks, they are rapidly emptied through the slot into the car. A sacked cargo is thus as expeditiously unloaded as bulk ore.

STEAMERS AT THE DOCK OF THE U. S. METALS REFINING CO., CHROME, N. J.

The railroad cars are sent up on the trestle over the ore bins and if an ore is to be mechanically sampled, it passes to a sample mill at the west end of the bins. This mill has a capacity of 30 tons an hour. It is equipped with Brunton samplers, pipe chutes and other accessory machinery of the usual type. Rich ore, such as that from Cobalt, is taken to a separate sampling plant for special attention, after being mechanically reduced to one-twentyfifth its original volume.

Ores of regular character that can be satisfactorily sampled while unloading from the steamer are taken in railroad cars directly to the trestle for unloading in the bins, which are behind and parallel to the furnace building. These bins were originally built as bedding floors; they have flat bottoms and on one side is the slotted opening such as is common in lead-smelting plants where the ores are blended.

With cheap labor and a comparatively small tonnage to be handled, it has not been considered worth while to change these bins for direct charging into charge cars, and a rather unusual method of preparing the charge is in use. Tracks for small end-dump cars are provided at each opening into the bins. The small end-dump cars are calibrated for the proper amount of each constituent of the charge, and laborers shovel the predetermined amount into them and then push them out a few yards to bent rail ends at the edge of the platform, alongside of which run the charge trains. The tops of the charge cars are slightly below the level of the platform, and the contents of the small end-dump cars are simply tilted into the charge cars. The furnace charge is thus made up by volume, but there is a scale suspended on a trolley for checking the weight of the individual elements of the charge. The shovelers soon become expert in approximating the correct amount and seldom require correction.

The charge trains consist of two cars of the usual roll or side-dumping type of about 8500 lb. combined capacity, but one of them is provided with motor and accessories for driving. Two charge-train crews handle all material to blast furnaces, a third crew, on day shift only, hauls the converter flux and flue dust.

The plant is built on a flat site and the furnace charge trains are elevated to the feed floor by Reedy 10-ton electric lifts, two of which are provided. The blast-furnace equipment consists of two 44x186-in. furnaces, originally built from designs by George K. Fischer. The furnaces each have 16 single-tier jackets extending to the feed-floor plates. There are six jackets on a side and two at each end. The details are shown in an accompanying illustration, so only brief reference will be made to one or two features. Instead of the cast tuyere thimble formerly used for the connection through the jackets, a piece of 4-in. double-extra heavy pipe is now welded in with an oxyacetylene flame, making a much improved connection. The oxyacetylene equipment is extensively used in the mechanical shops of this company. It is of particular advantage in patching furnace jackets, but finds frequent use in a wide variety of repairs. It may be mentioned in passing that repairs to cast-steel ladles made with this apparatus were not so satisfactory, the iron

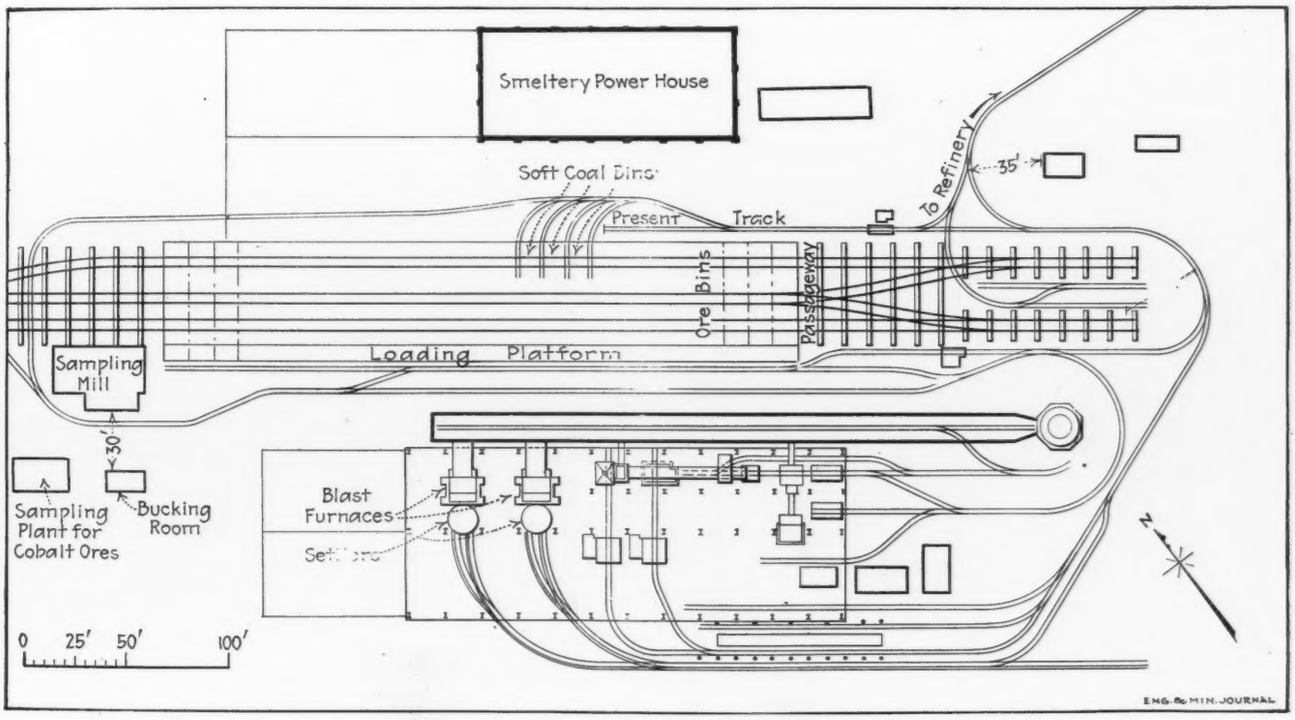
patch wearing out before the remainder of the steel shell. The special furnace and straightening table developed at this plant for straightening warped furnace jackets has been already described in the JOURNAL[1].

The breast jackets for the smelting furnaces are cast in the refinery; they are made of wire-bar copper (thus locking up no precious metals), poured around 1¼-in. extra-heavy pipe for water circulation. A steel water-jacket spout, with cast-iron lip cooled by a water pipe, taps the blast 8½ in. The furnace bottom plate is lined with 12-in. chrome or magnesite brick. The space corresponding to the breast jacket at the back of the furnace is simply bricked up, and drilled through when it is desired to tap out the furnace in emergency. The settlers are of the usual circular type, 14 ft. in diameter, and

CAPACITY OF WORKS ABOUT 200,000 TONS PER ANNUM

When one furnace is in operation, about 350 tons of charge are smelted per day, or 6.16 tons per sq.ft. of hearth area. At 360 days, this would give an annual capacity on a one-furnace basis of 126,000 tons of charge. With one furnace in operation no time is lost for repairs as the second furnace is held ready as a substitute. Allowing for repairs and a small percentage of circulating material, an annual capacity of 200,000 tons of new marginal material is indicated on a two-furnace basis.

The slag from the blast furnaces was formerly removed in pots but for the last two years it has been granulated with salt water supplied by centrifugal pumps from a central pumping plant that also serves the re-



PLAN OF THE U. S. METALS REFINING CO.'S SMELTERY, CHROME, N. J.

lined with chrome brick; an ordinary cast-iron tapping block is used.

SHEET-STEEL CHARGING DOORS ABANDONED

The sheet-steel charging doors formerly used on the furnaces at this plant have been replaced by heavy cast-iron doors. These do not warp, and thus they reduce the admission of extraneous air and improve the draft.

The furnace charges usually weigh 8500 lb. and are dumped directly into the furnace after the coke which is loaded and dumped separately. The coke usually amounts to 11 or 12% of the charge weight. The furnace tops are maintained in good condition, and considering the large proportion of fines, little difficulty is experienced from the formation of crusts. The flue dust was formerly put back into the furnace when not too great in quantity, but now flue-dust nodules are charged —without extra coke if the furnace is in good condition.

[1]"Straightening Furnace Jackets," by Claude T. Rice, "Eng. and Min. Journ.," Apr. 1, 1911.

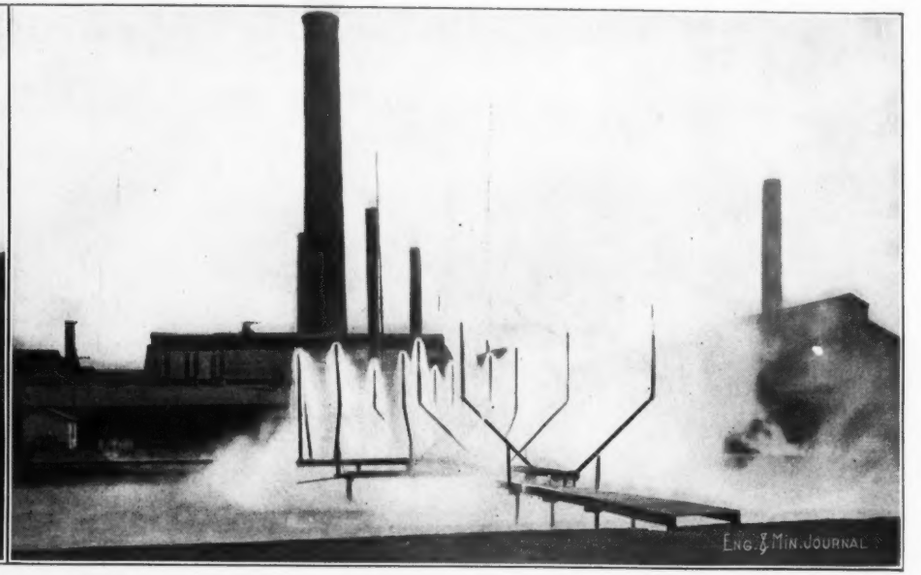
finery. The granulated slag is run to a pit outside the furnace building and is loaded in railroad cars by a locomotive crane. This slag, after loading, is sold, if high enough in iron, otherwise it is used for ballast or filling.

SLAG SOLD FOR ITS IRON CONTENT

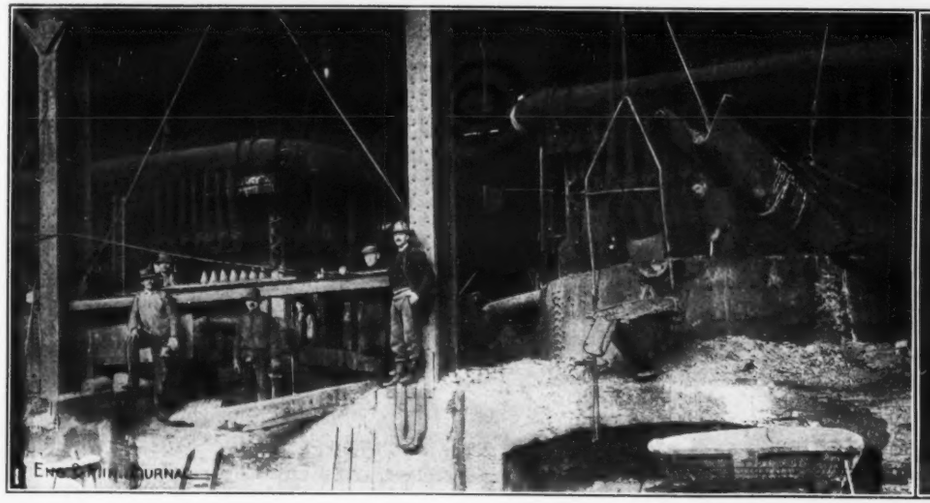
The slag that is sold must carry at least 43% Fe and not more than 1.0% S. A typical slag sold for this purpose ran: FeO, 59.78%; insoluble, 29.94 (SiO_2, 25.24); CaO, 0.7; S, 0.7; Cu, 0.79%. The principal difficulty in this connection is to secure a slag sufficiently low in sulphur; this element exhibits at times inexplicable fluctuations that do not correspond to current matte assays.

When not making a slag for sale, the normal slag for a half month had the following composition: FeO, 50.67%; insol., 36.39 (SiO_2, 32.05); CaO, 1.37; S, 0.77; Cu, 0.76; Ag, 0.16 oz.; Au, 0.0025 oz.; MgO, 1.06%; $BaSO_4$, 3.10; Pb, 0.22; As, 0.094; Ni, 0.07; Al_2O_3, 4.10; Mn, trace; Zn, 2.35; P, 0.063%. In a re-

SMELTERY STACK, SHIPS AT DOCK IN DISTANCE



COOLING POND



BLAST FURNACES

CASTING CONVERTER BARS FROM LADLE

cent month, December, the wet tons smelted with one furnace amounted to 9726, equivalent to 9587 dry tons, containing an average of 0.123 oz. Au, 4.24 oz. Ag, 16.3% Cu, 26.6 Fe, 24.1 insol., 0.54 CaO, and 17.5% S. The large amount of copper on the charge and the consequent high grade of matte are in part responsible for the high copper content of the slags, this being further augmented by the high specific gravity of the iron slags. The management at this custom smelting plant considers that, under the conditions prevailing, it is more economical to make a slag of the above copper content than to purchase barren limestone and pay the cost of smelting the same, when there is an ample offering of profitable ores containing the iron flux, and especially when the conditions permit the making of a slag that can be sold, thus counterbalancing commercially the higher metallurgical loss involved.

COPPER REFINERY OF THE U. S. METALS REFINING CO., CHROME, N. J.

A 50% MATTE CONVERTED ON BASIC LINING

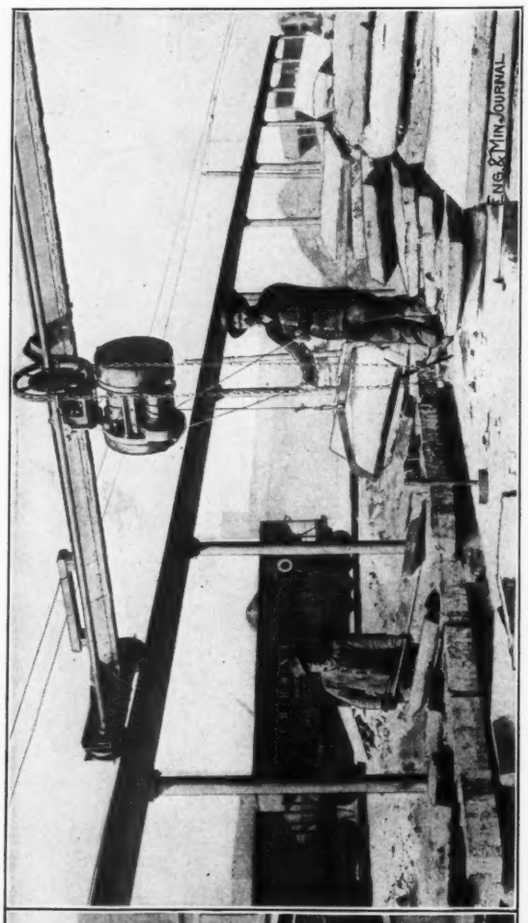
The matte fall averages about 14% and the grade of the matte varies from 40 to 70% copper, usually between 50 to 60%; the mattes carry up to 3% in nickel, which is later recovered in the electrolytic refinery.

The matte is now converted in small basic-lined shells under license from the Peirce-Smith Converter Co. The plant was originally equipped with six Allis-Chalmers barrel-type converter shells, 84x126 in., for which two converting stands were provided. The shells were first operated with acid lining, but since the fall of 1911 have been lined with magnesite brick. Difficulty was experienced at first in lining the caps with brick, and a slight modification of the cap was made, which overcame the trouble.

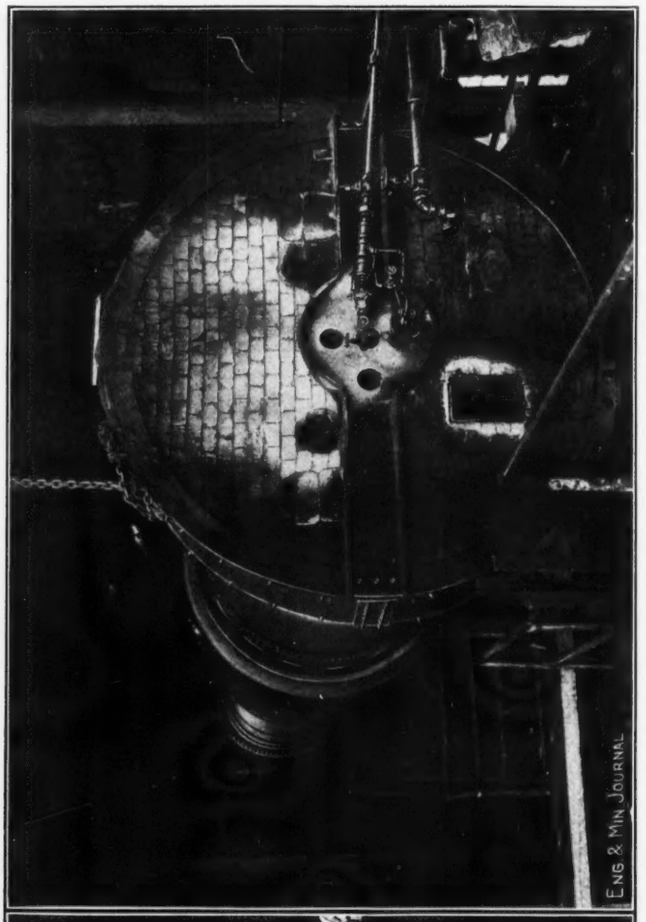
Air is supplied at 10-lb. pressure and no difficulty is now experienced, either with slopping or with the building-up of the converter mouth. A little trouble with mouth accretions arises when a 70% matte is being converted, but at present the mattes seldom exceed 55%. These small converters are operated with unusual smoothness and it is exceptional that such slopping as is indicated in the illustration occurs. For converter flux, oxidized ore carrying 60% SiO_2 is used. This is dried in a revolving steel cylinder, about 30 in. in diameter and 20 ft. long. It is unlined and has six longitudinal shelves. Oil is used for heating and about 1000 gal. are consumed per month in drying about 650 tons of ore. A man is employed to feed the ore by hand, but later it is planned to feed the drier automatically and to connect it with the general dust-chamber system. The converter slag is poured into the blast-furnace settlers.

THE BROWER CONVERTER HOOD

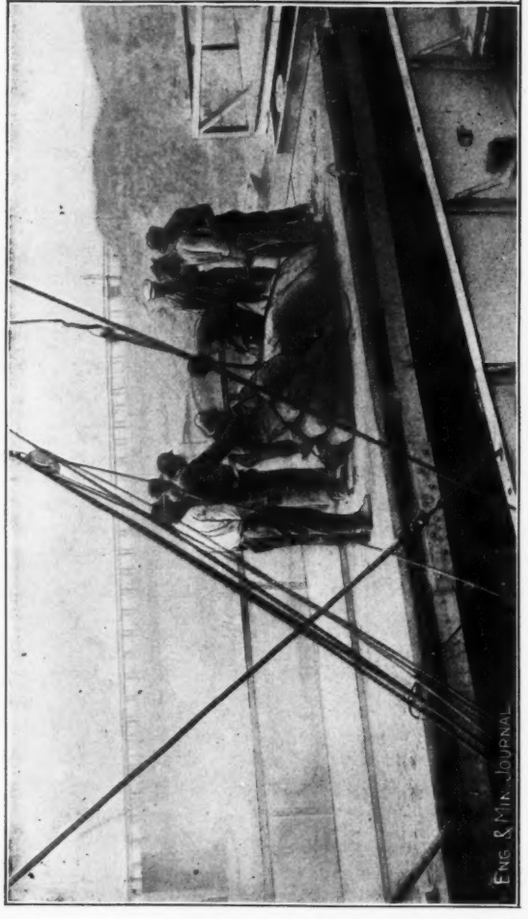
The converter hoods at this plant are worthy of special mention and will be described in detail in a later article. They are shown in one of the accompanying halftone engravings and are the design of C. L. Brower, chief engineer. The hood proper consists of two steel castings, bolted together, structural-steel cross-pieces enabling it to be hung on supports attached to the building columns. The hood is of much smaller section than is usually considered necessary, but its mouth appears to be in just the right position to take the fumes, and there are few converter rooms so free from smoke as this one. When the hood becomes clogged with accretions, it is simply lifted off by the crane and replaced by another. A man on the converter floor cleans the first hood as occasion permits.



HANDLING PIG COPPER FROM MOLDS



FLUE-DUST NODULIZING KILN



UNLOADING ORE FROM VESSELS

CONVERTERS

Copper Cast from Ladle

Two 40-ton cranes serve the converter floor, one being occupied much of the time in pouring the copper. When a charge is finished, it is poured into a special tilting ladle, shown in one of the accompanying engravings; the copper is then poured into copper molds on narrow-gage trucks, there being four molds each on eight trucks. This system permits the converter to proceed with a new charge without the old tedious pouring, and as the trucks are not moved there is less spilling of copper than by the old plan of pushing the trucks under the converter. The bars are unloaded on a platform, and on day shift all are trimmed and loaded on refinery cars with a traveling crane carrying a ½-ton Sprague electric hoist.

In a recent month, 3,300,000 lb. of copper were converted in this plant. The basic linings in these small converters usually produce 1,500,000 lb. of copper before requiring repairs at the tuyeres, and recently one converter made over 2,000,000 lb. before stopping for repairs. None of the converters has had a complete new lining, and although the original basic linings have been in use over 1½ years, they still appear good for indefinite service, excepting, of course, the patching at the tuyeres.

Anaconda Lining Practice Followed

The method of lining the converters is modeled on the Anaconda practice; the magnesite brick are laid with a sodium-silicate mortar on a 1-in. bed of peagrain magnesite—to allow for expansion. At the tuyeres, in place of the brick a belt is tamped about 8 to 10 in. high and 14 in. thick, consisting of a mixture of 80% magnesite dust and 20% of a 40% sodium-silicate solution; in half an hour it is set fairly well, and at the end of a few hours this part of the lining is said to be practically as hard as the brick portion. For the tuyere connection, a 1¼-in. double-extra heavy wrought-iron pipe is used. This method of lining at the tuyeres reduces the expense of repairs to lining, and the work may be accomplished expeditiously, though the latter is not a desideratum at this plant, as there are spare shells on account of the requirements of the old acid-lined process. When a shell requires repairs, it is simply removed from the converting stand and a fresh shell substituted.

Nodulizing Flue Dust in Cement Kiln

The flue-dust production in the smelting plant amounts to about 10% of the furnace charge. This was formerly returned directly to the furnace, or when production was too great to be handled in this way; it was stockpiled pending a satisfactory method of treatment. The furnace downtakes discharge into an elevated brick-and-steel flue with hopper bottom, permitting it to be emptied directly into charge cars. The flue is 288 ft. long, and the connection to the center of the stack adds 23 ft. more to the travel of the gases. The flue is 12 ft. wide inside and has a cross-section of 170 sq.ft. to the line of the hoppers, the total cross-sectional area being 212 sq.ft. The stack is of brick and is 200 ft. high and 12 ft. in diameter.

The flue dust in a monthly sample averaged: Au, 0.17 oz.; Ag, 15.20; Cu, 10.75%; Fe, 32.02; insol., 20.83; CaO, 0.82; S, 8.24; As, 0.88%. Several patented methods were considered for the handling of the flue dust but after trials in the experimental kiln of J. H. Payne at Yorktown, Va., it was finally decided to try nodulizing it in a 6x60-ft. cement kiln. This is lined with fireclay brick and is fired with oil. The dust is fed by a screw conveyor, protected by a water jacket, and about 50 tons of dust are nodulized per 24 hr. At the time of my visit, an excellent furnace material was being produced, practically none of which would again be carried into the flues.

While the kiln may not always work so well as it did on this occasion, there seems little doubt that with this flue dust a satisfactory nodule can be produced. Besides the power for rotating and feeding, the kiln consumes about 500 gal. of oil per day and requires one attendant on each shift. The matter of accretions within the cylinder is the principal operating difficulty, though it is not felt to be a serious one. Several plans for the removal of the accretions mechanically have been under consideration. While the nodulizing kiln has been in operation for several months, the management has not definitely committed itself to this method of handling the flue dust.

Power-House Equipment

The smeltery power-house equipment includes a No. 9 Roots blower, direct connected to a 11 and 24x36-in. tandem-compound Hamilton engine, operated at 150-lb. steam pressure and a vacuum of 26 in. The blower operating at 100 to 140 r.p.m. as required, supplies air to the blast furnaces through a 32-in. main at 36-oz. pressure. There is a small 6000-cu.ft. blower also connected with this main.

Converter air is supplied through a 20-in. main by a Nordberg cross-compound blowing engine with steam cylinders, respectively 13 and 28 in. in diameter, and two 30-in. single-stage air cylinders with a stroke of 42 in. This unit operates at 130 r.p.m., steam pressure 150 lb., vacuum 26 in., and supplies air at 12 lb. Steam and electric power are supplied from the refinery generating plant and charged to the smelting operation. No working costs are available on account of this works being essentially a custom plant.

Nevada Consolidated Copper Co.

The report of the Nevada Consolidated Copper Co., operating at Ely, Nev., for the quarter ended Mar. 31, 1913, showed a production of 14,523,565 lb. of copper. The production for the quarter was somewhat curtailed, due to extraordinarily cold weather, the winter having been unusually severe. Operations in the pits, therefore, were practically confined to higher levels in the Eureka and to the Hecla area, resulting in the mining of ore of lower grade than would otherwise have been secured. During January all stripping operations were discontinued for a period of 10 days in order to conserve the coal reserve to insure continuous operation of the shovels handling ore to supply tonnage to the concentrator, the difficulties experienced by the railroads on which the coal mines are located causing irregular deliveries of coal during January. The 12-in. North Creek pipe line froze at the height of the cold spell, necessitating the digging up and thawing of 4000 ft. of this water line.

Ore milled during the quarter amounted to 729,115 tons of Nevada Consolidated ore, averaging 1.54% copper, of which 656,492 tons were from the pits, and 72,623 tons from the Veteran mine.

The statement of profit and loss shows a charge to undivided profits of $222,117 for the quarter, after the

payment of the fourteenth quarterly dividend and the charging off of $119,520 for ore extinguishment, and the additional sum of $131,728 paid to the Steptoe company for depreciation. Actual stripping expense amounted to $216,606, of which $144,476 was charged to operating costs.

Arizona Copper Co.

The report of the Arizona Copper Co. for the year ended Sept. 30, 1912, shows a production of bessemer copper of 38,132,000 lb., as compared with a production of 34,569,019 lb. for 1911; this is the largest output since the company began operations. The total ores mined from the company's properties during the year amounted to 927,116 dry tons and the yield, as indicated by the smeltery returns, averaged 41.15 lb. of copper per ton of ore, a decrease of over 5 lb. as compared with the previous year. Of the total ores produced by the mine, 655,396 tons came from the Longfellow group and 271,720 from the Metcalf group. About 96% of the ores mined were concentrating, the remaining 4% being direct smelting ores (including pyrites for the acid plant and siliceous ores for converter lining). Of the total copper produced, 84½% came from sulphide ores and 15½% from oxides.

The extension of the Humboldt electric haulage system to the Coronado incline for the purpose of conveying the ores of that mine to No. 6 concentrator at Morenci was decided upon, and the second level was chosen as the best to lay out this line. The work of construction was well advanced during the year. At the Humboldt end, the work involved driving about 3500 ft. of tunnel between the Clay shaft and the Queen incline, where it comes to daylight. Of this driving, 762 ft. was done in the month of March, 1912. Coming to the surface at the Queen incline, the haulage road has been graded round the steep hillsides, passing through several short tunnels, 6622 ft. to the foot of the Coronado incline. This portion of the work has been done in a thoroughly substantial manner and, with the exception of the electric trolley line, is now practically completed.

For the development of the lower levels of the Coronado mine and for the more economical handling of the ores produced, a deep adit is being driven from the foot of the incline to connect with the Matilda shaft. This tunnel is a continuation of the electric haulage road above described, and, when finished, will complete the connection between the Coronado mine and the concentrator at Morenci, a total distance of four miles. A temporary power plant consisting of boilers, condensers and electric generators for furnishing light and operating ventilating fans was provided, and the necessary blacksmith shop, office, storehouse and magazine were erected at the portal near the bottom of the Coronado incline. The tunnel will be 8 ft. wide by 9 ft. high, with a slight grade in favor of the load and for drainage purposes. On Dec. 31, 1912, the face had been advanced 2746 ft. from the portal, the total distance to the Matilda shaft being 6310 ft. At the Morenci end of this system an underground track scale has been installed capable of weighing four cars of ore at a time: and ore pockets at No. 6 shaft are being constructed with a capacity of 2500 tons. The mines of the Longfellow group operated during the year were the Humboldt, producing 447,478 tons of ore; the Clay, 88,159 tons; the Petaluma and Carasco, 8880 tons; the Liverpool, development work only; the Yavapai, 36,269 tons of concentrating and smelting ores, 3299 tons of pyrites and 73 tons of siliceous ore for converter lining; the Joy pyrites vein, 3126 tons of pyrites; and the North Extension, 64,711 tons.

The production at the Metcalf group of mines was divided as follows: From the Metcalf mine, 106,561 tons; King mine, 21,019 tons; Mammoth mine, 12,020 tons; Keystone mine, 813 tons; Coronado mine, 130,728 tons.

During the year, 782,100 dry tons of ore were concentrated by the sulphide concentrators, the average ratio of concentration being 6.74:1; No. 6 concentrator at Morenci treated 547,567 tons of this amount. Successful concentrate redressing plants have been installed during the year. The oxide concentrators treated 108,230 dry tons of ore, the tailings from which, amounting to 89,890 dry tons, were treated in the leacher. From these ores 9.71% of the total copper production was obtained. The sulphuric acid plant supplied the leacher with 3998 tons of acid.

The smelting plant treated 158,529 tons of ore and concentrates; with fluxes and byproducts the amount was 236,035 tons. The average yield of copper from ores and concentrate was 12.03%. In the converter department experiments were made with basic lining in one converter, which were so successful that the siliceous lining will be replaced by basic lining in all the plant.

The sum of £178,983 was expended during the year on the smelting plant, although some delay has taken place in consequence of the difficulties experienced in obtaining prompt delivery of material. The progress has been so satisfactory that it is reasonable to expect the smelting works to be in operation by the end of the summer or early in the autumn.

Potash in Death Valley, Calif.

Borings in search of potash salts by the Geological Survey in Death Valley, Calif., have not given encouraging results. The best of the natural brines found, a surface ground water, gave only 1.53% KCl, while the average of 15 brines tested was only 0.94% KCl, which is about the average content of most natural desert brines.

A vast amount of saline material is accumulated in the bottom of this valley, but the mode of its deposition probably is not favorable to selective crystallization on a large scale. Segregation of potash or any other portion of the soluble constituents of the waters may have taken place to a slight extent in the individual salt crust layers, but under the conditions described any such differentiation is likely to have been restricted to the individual layers as units, and therefore has occurred on a scale so small as to be of doubtful practical importance.

The Largest Direct-Current Generators Ever Built have just been installed in the Canal Road plant of the Cleveland Electric Illuminating Co., according to "Power," Mar. 25, 1913. They are two 3750-kw., 275-volt, shunt-wound machines, driven at 180 r.p.m. by steam turbines through 10:1 Westinghouse reduction gears. The large gear of the reduction mechanism can be described as a herringbone gear, split circumferentially, with the halves moved apart. It is 100 in. in diameter, has 259 teeth, transmits 5000 hp., and develops a speed of 54 miles per hour at the pitch line.

The Crushing-Surface Diagram

By Arthur O. Gates*

SYNOPSIS—An effort to reduce to graphic form the exposition of the energy absorbed in reducing rock from one size to a smaller one. The diagram is based on Rittinger's law, which is believed to be more applicable to the problem than that of Kick. The diagram presents a convenient means of comparing the crushing efficiences of various machines, a system which will be valuable in many branches of metallurgy. The conclusions are contrary to those found and expressed by other investigators.

In view of the importance of crushing efficiencies in various industries, and the frequent discussion taking place on this subject, the diagram which may be called the crushing-surface diagram is submitted as a means of comparison and study of crushing conditions. The scheme was discovered during the summer of 1910, when trying to understand why one tube mill did not do the work expected of it on the basis of what another was doing on "a similar ore just as hard."

Diagram Based on Rittinger's Law

First it should be stated that this diagram is based on Rittinger's law, which is interpreted to mean that the work done in crushing is proportional to the surface exposed by the operation, or better expressed for this purpose, the work done on a given mass of rock is proportional to the reciprocal of the diameter of the final product, assuming that all the mass has been reduced to one exact size, which is only theoretically possible.

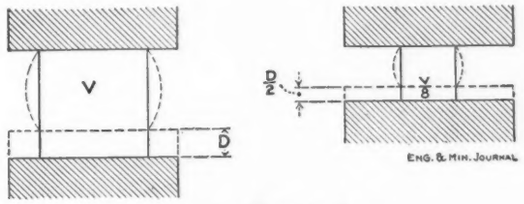


Fig. 1. Kick's Law

100-Mesh Cube	200-Mesh Cube
Area one face = A	Area one face = $\frac{A}{4}$
Average resisting force per sq.in. = F	
Energy = FAD	Energy = $F \frac{A}{4} \frac{D}{2} = \frac{FAD}{8}$
∴ Energy Proportional to Volume	

Kick's law is frequently referred to in connection with this subject, especially since the publication of H. Stadler's[1] work, and is thus expressed: "The energy required for producing analogous changes of configuration of geometrically similar bodies of equal technological state varies as the volumes or weights of these bodies." This law does not apply as much to crushing as to deformation of bodies before rupture takes place.

Kick's Law Not Applicable

In Fig. 1 are represented two particles of ore "of equal technological state" shown as cubes between the faces of a crushing or testing machine. Assuming the theoretical mesh, equivalent to the reciprocal of the diameter, and using concrete values, we have a 100-mesh particle with eight times the volume of the 200-mesh particle, and with an area per face four times that of the 100-mesh particle. The dimensions are as 2 to 1, and the bodies being similarly deformed within the elastic limit without fracture, the energy that must be applied in each case to produce this deformation is the product of the average resisting force per square inch, the same in both cases, by the area worked against and by the distance through which this average force works. As shown in the figure, in this particular instance the energy absorbed is proportional to volume and it can be similarly shown for the general case. On the gradual release of the external pressure the energy absorbed is given back to the machine producing the deformation and the body returns to its original shape. It should be noted that the body has been deformed only by a gradually increasing pressure, the first increment of deformation not requiring so much pressure as the last. In case the body has been deformed beyond its elastic limit either the whole mass of particles have been reduced to the molecular state by the freeing of their bonds with adjacent particles, which never happens, or fracture takes place along a few surfaces by the breaking down of some of the weaker bonds, and the new particles thus formed are free to resume their original shape insofar as they are not held between the machine surfaces. The energy given up by them is probably used in some sort of lever action in making fracture planes. So the energy absorbed according to Kick's law does not stay in the particle after pressure is released and therefore this law does not govern to any great extent the amount of energy absorbed in crushing.

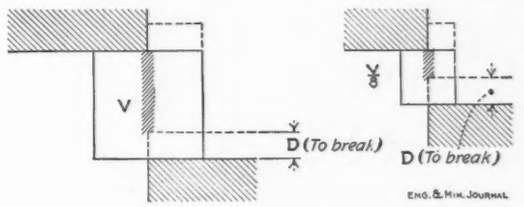


Fig. 2. Rittinger's Law

100-Mesh Cube	200-Mesh Cube
Area one section = A	Area one section = $\frac{A}{4}$
Average resistance to shear per sq.in. = F	
Energy = FAD	Energy = $F \frac{A}{4} D$
Surface produced = 2 A	Surface produced = $2 \frac{A}{4}$
∴ Energy Proportional to Surface	

Energy Proportional to Surface Produced

Reference to Fig. 2 will explain how Rittinger's law applies. Supposing that it were possible to hold similar cubes between the two offset faces as shown, and that forces were applied until the deformation shown by the dotted lines was obtained, it will be seen that only the molecules along the vertical center line are stressed and deformed, the mass of the cube away from this surface receiving practically no pressure or deformation. The energy in this case required to produce rupture will be the product of the average resistance to shearing per square

*Purdue University, Lafayette, Ind.

[1]Trans., I. M. M., Vol. 19, "Grading Analyses and Their Application."

inch by the area along which rupture takes place, and by the distance the two offset faces move together. The average resistance to shearing is a variable quantity, as the deformation increases up to rupture. To reduce to cubes, this amount of energy must be multiplied by three, as three similar fracture planes must be made to produce cubes. And it will not be hard to see that the distance through which the offset faces must move in either case must be the same and not proportional to the thickness of the piece. To break the molecular bond between adjacent particles would require the same movement regardless of the thickness of the piece.

It will be noted that if eight of the half-diameter cubes be sheared to produce cubes of half their size, the new surface presented will be double that formed when the single large cube is sheared into half-size cubes, and also that the energy required in the case of the smaller cubes is double that required in the case of the larger cubes. This should demonstrate that energy applied to crushing is proportional to the surface produced.

Surface Proportional to Reciprocal of Diameters

In this scheme we start from an infinite mass, say the side of a mountain, and consider that particles are sheared off in the form of cubes, each particle having new surface added to it equal to that exposed before the new shearing operation was started. This eliminates the "minus one" part of the equation given in Richards' "Ore Dressing" on the subject. For example, if we cut off from a cubical corner of this infinite mass 100 slabs 1 in. thick and 100 in. square, and then cut the slabs up into one-inch cubes, 6,000,000 sq.in. of new surface is produced. If instead, 200 half-in. slabs were cut from the same corner and likewise cut up into half-inch cubes, the area would be 12,000,000 sq.in., just double the surface of the one-inch cubes. This shows that the surface produced on equal masses of rock is proportional to the reciprocal of the diameters, as can be proved in a similar manner for any sizes. Also the surfaces of two lots of the same sized particles will be proportional to their values, and if of the same substances, proportional to the weights of the lots.

Energy May Be Represented by an Area

From the above we see that the energy absorbed by a lot of given sized particles is proportional to the product of their surface by their weight, which can be shown graphically by an area. And if we have a series of these areas, placed side by side, and representing the summation of the energies of the different sizes produced by a crushing operation, the total area is proportional to the energy expended on the rock. And when the cumulative weights of the different sizes are plotted consecutively, as in Fig. 3, the area between the sizing-analysis curve and the zero lines is proportional to the work expended on the rock in breaking it down from the infinite mass. And then if further crushing takes place on all or part of this rock and the new-sizing analysis is plotted, the area between the two curves is proportional to the further work done. This is the crushing-surface diagram.

For rough work, comparing the work of one day with that of another, the screen analysis may be plotted, mesh against the percentages, and areas compared, etc. For accurate work, such as the determination of constants for different rocks, or for the comparison of the efficiencies of different crushing machines, etc., the actual reciprocals of the diameters should be plotted. In fact, it is no hard matter to locate on the diagram the reciprocals of the diameters for the screens used; or better still, screen manufacturers could be sufficiently induced to furnish pads of coördinate paper, on which are drawn these lines corresponding with their standard sets of screens.

Several Uses for the Diagram

Two uses are already suggested; the first, determination of crushing resistances of various rocks, and second, the determination of crushing-machine efficiency. Only with a knowledge of the former, can comparisons be made of the operation of two machines at different places. And I believe that this diagram will make necessary some revision of the constants for the crushing resistance of rocks. All tests of rocks have been made on single pieces and the crushing strength determined from an average of a number of tests. Where surface has been determined it is only that of the larger pieces involved in the fracture. No calculations based on the surface of the very fine particles have been made. One thing which will be noticed in nearly every screen analysis that is plotted as a crushing-surface diagram, that the curve is of the form of a hyperbola, indicating a strong probability of the presence of

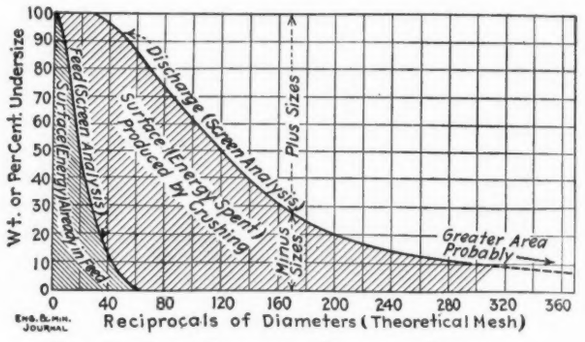


Fig. 3. The Crushing-Surface Diagram

particles of 1000 and even 10,000 mesh. Some allowance for the probable area of these very fine particles must be made, and when that is done it will very likely be found that there is a greater area in the minus 200-mesh particles than in the plus 200-mesh material. There is no question but that the surface of the minus 200-mesh particles must be considered in crushing calculations. The neglect of this surface, which usually is not wanted, makes any reasonable comparison impossible, between crushing operations that are not very much alike. The agriculturists in the study of soils do not hesitate to measure and discuss particles of clay as small as 0.0002 in. diameter, and so I see no reason why milling operators should avoid these sizes and talk of colloids as soon as they get past the 200-mesh line. The use of logarithmic paper can be invoked to find out about the minus 200-mesh particles as I may show later.

Important Use in the Cyanide Plant

Other uses for this diagram should be in the cyanide plant, where time of solution depends upon surface exposed, and the amount of surface is a factor in filtering operations. In the cement industry, surface must play an important part, for each particle of stone or sand or fine material must be coated with cement particles before a good bond can be made. The amount of cement

could be made proportional to the area of the diagram for the material used.

In concentrating-mill operations, surface is fully as important in the concentrating department as in crushing operations. It is surface that limits the tonnage that can be put through a given machine, only a certain number of layers of particles can be treated at one time on a given surface, which explains the small capacity of fine concentrating machines. Based on surface, the distribution of feed to different machines can be made more efficiently. Also the character of the crushing operations can be modified to give the largest reduction possible with the minimum production of useless fine surface.

The first experiments to prove some of the facts in the case were made in Salt Lake City, in 1910, when I used a small gravity stamp of 22 lb. weight, but the foundation was not satisfactory and other conditions compelled the dropping of the work which was only taken up again when I came to Purdue University a year ago. Here I found in the laboratory for testing materials, a hydraulic testing machine capable of exerting and recording pressures up to 150,000 lb., which just suited this class of work.

Diagram of Tests Made

The two diagrams, Figs. 4 and 5, are made from the logsheets of this test, all records of crushing pressures

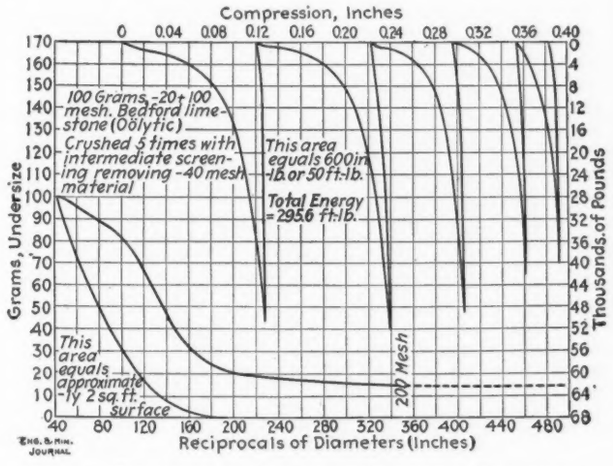

Compression, Inches
0 0.04 0.08 0.12 0.16 0.20 0.24 0.28 0.32 0.36 0.40
100 Grams, -20+100 mesh. Bedford limestone (Oölytic)
Crushed 5 times with intermediate screening removing -40 mesh material
This area equals 600 in.-lb. or 50 ft.-lb.
Total Energy = 295.6 ft.-lb.
This area equals approximately 2 sq. ft. surface
200 Mesh
Grams, Undersize
Thousands of Pounds
Reciprocals of Diameters (Inches)
Eng. & Min. Journal

Fig. 4. Diagram of Tests on Testing Machine

being plotted directly on the sheet against the movement of the faces of the machine. The triangular curved areas are the record of the work on the machine, and are a measurement of energy. Each crushing movement was continued until the pressure was rapidly going up with little movement of the faces, then the pressure was gradually reduced and we got the return curve showing that some energy was being given up by the rock. The machine was then opened, the finer sizes screened out and the coarse returned and crushed again. After the crushing was complete as far as was considered advisable, the screen analysis was made and plotted as the weights were determined. One hundred grams was used in each case, its original screen analysis being the first thing plotted on the paper.

Without going into the calculations in detail, the energy absorbed in the case of Fig. 4 was 166.3 ft.-lb., while in the case of Fig. 5, the energy absorbed was 295.6 ft.-lb., about 80% more. And yet the area of the surface under 200 mesh was greater in the case of the former. The only way to account for the energy is to go beyond the 200-mesh line, and doing this, using logarithmic paper and assuming that the curve continues its law indefinitely among the smaller particles, I find that out to 5000 mesh for Fig. 4 the energy is equal, per unit area, to that in Fig. 5, out to 11,000 mesh. Both are calculated to have one-half of 1 per cent. at those sizes.

I do not see any other way of accounting for this energy, but it is so revolutionary as to make a serious study necessary before it will be universally adopted. It ought to be definitely known whether Rittinger's or Kick's law, or either of them, applies to the crushing problem in mill work, and if I have started a discussion which will produce this result, I shall be satisfied.

The Welfare of Employees

In the present day welter of coöperation, old-age pensions, compulsory insurance, etc., there is a distinct tendency on the part of corporations to take a greater and greater interest in the welfare of their employees. Whether this is spontaneous, or is merely a sop to public opinion, it is, nevertheless, an interesting and highly important phenomenon. Two manifestations of the tendency somewhat connected with the mining industry have lately come to our attention. The Dodge Manufacturing Co. has conducted a rather extensive investigation

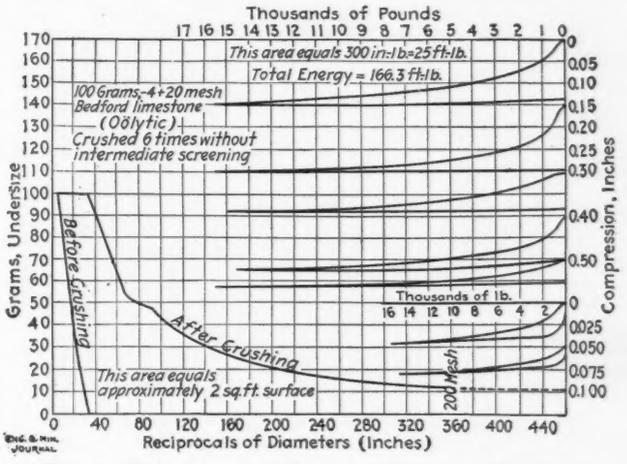

Thousands of Pounds
This area equals 300 in.-lb.=25 ft.-lb.
Total Energy = 166.3 ft.-lb.
100 Grams, -4+20 mesh Bedford limestone (Oölytic)
Crushed 6 times without intermediate screening
Before Crushing
After Crushing
Thousands of lb.
This area equals approximately 2 sq. ft. surface
200 Mesh
Grams, Undersize
Compression, Inches
Reciprocals of Diameters (Inches)
Eng. & Min. Journal

Fig. 5. Diagram of Tests on Testing Machine

to determine the extent and the characteristics of employees' relief associations in industrial concerns, and is presenting for discussion in its publication, *The Dodge Idea,* the results of this investigation. The other example is that of the National Lead Co., which in its annual report for 1912, summarizes its work to promote safety and health among its workmen.

Extensive Investigation by the Dodge Manufacturing Co.

The results of the Dodge investigation are too extensive even to summarize, but some points of interest may be noted. Practically all of the benefit funds investigated provided compensation for temporary disability due to sickness. The average cost per member per year from sickness and accident combined, covering 350,000 members, was $3.42. The relations between the funds and the employing establishment varied, but 30% of the funds received regular contributions from the employers. Few

cases were found where permanent disability received compensation. In only 15% of the funds was membership more or less compulsory.

Elaborate Precautions Taken by the National Lead Co.

The idea underlying the work of the National Lead Co. is not so much mutualization as paternalism. The agitation against industrial poisoning is well known. This attempt of the most prominent concern in the lead manufacturing industry to decrease and minimize lead poisoning in its plants, is praiseworthy in the highest degree. Not the least interesting feature is the difficulty encountered here, as in most efforts along sanitary and safety lines, in overcoming the carelessness of the men themselves. The necessity of paying a man 5c. to take a bath is rather illuminating. The report mentioned gives the following description of the work done:

In the manufacture of the various products of lead, there are two sources of danger to the health of workmen therein employed, viz., the fumes arising from the smelting or melting of metallic lead, and the dust arising in the process of making white lead and lead oxides. To attempt to state, even in a brief manner, the experiments and studies conducted through a long term of years, first to minimize and later to entirely eliminate these dangers, would be to give a history of the company's mechanical progress. The results attained are what really count, and it is enough to say here that in our new plants, by the skillful use of powerful fans and air suction, inclosed air-tight machinery and mechanical devices to replace men, we have practically banished the dangers from fumes and dust.

However, despite the employment of the best mechanical devices, there are at times weak spots in the system because of the human element involved. This human element is naturally careless, indifferent to known dangers, and extremely difficult to guide in the path wherein lies safety. The best, and in fact the only, way to neutralize this attitude and safeguard against its resultant dangers to health, is by teaching habits of personal cleanliness, and prohibiting, as far as possible, indulgences which tend to injure health.

Workmen are provided with sanitary respirators, the wearing of which prevents the inhalation of dust. At the various plants is provided complete welfare equipment of the most modern type. The daily routine of one of our workers who utilizes what is freely placed at his disposal is somewhat as follows:

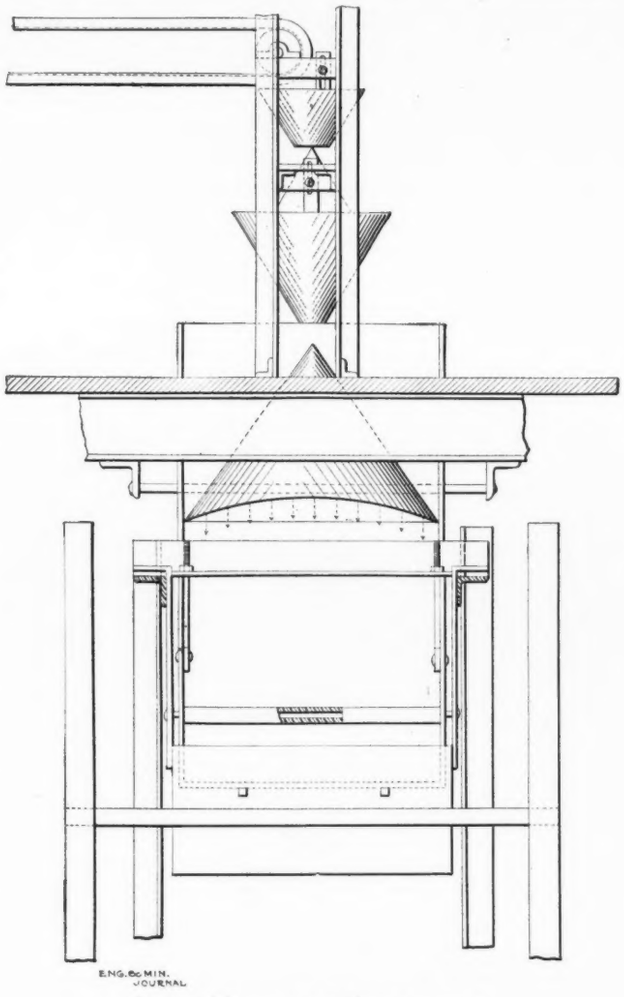
On entering the works and after registering his arrival, the workman proceeds to the locker room and places his street clothes in his individual steel locker; a few steps takes him to another adjoining locker room, where from another locker, he gets and puts on his working clothes, and procures his sanitary respirator. Respirators are supplied and kept clean free of charge. Working clothes are at some places supplied free of charge, at others at a nominal cost, this being a minor detail of policy being worked out and relating to the care of clothes. The clothes are laundered free of charge by the company. When luncheon time arrives, a thorough washing of the hands and face with soap and warm water is required; after which, luncheon is eaten at tables in clean, well-lighted, airy dining-rooms, separate and removed from all manufacturing departments.

When quitting time arrives, after placing work clothes in the locker, a step takes the workman to large shower baths, so numerous as to be ample for the entire force. The water is tempered to the right point; after bathing and dressing in his street clothes, refreshed from his day's work, he is ready to start for home. The company provides soap and towels, and urges the men to use the baths as often as they will, and always on the company's time.

It is interesting, in passing, to remark on the great difficulty experienced, particularly with foreigners, in inducing them to use the baths. This is a study in itself, and numerous ingenious devices are used. In one works, men are actually paid 5c. for each bath they may take. Each works has a regular physician who makes an examination of every workman once a week; a card-index history of every workman is kept, showing his health history as far as possible. Even the slightest ailments receive instant attention, and the oversight and care of the workman's health is far more thorough than he receives in his ordinary private life. All this is done without cost to the workman. Rest rooms are provided, and advice and instructions are printed and distributed.

Sicka Mixer and Distributer

Louis T. Sicka, of Tooele, Utah, has devised (U. S. pat. 1,047,316) an apparatus for thoroughly mixing crushed ore and distributing it evenly to sinterers of the traveling-grate type or other similar devices. From the accompanying illustration the mode of working will be evident. The mixing is accomplished by feeding the ore from a hopper in the form of an inverted frustum of a cone to the apex of a cone with the same vertical axis. This, in turn, discharges into a frustum similar to the hopper. The series may be thus continued until a sufficiently even mixture results. The final hopper discharges



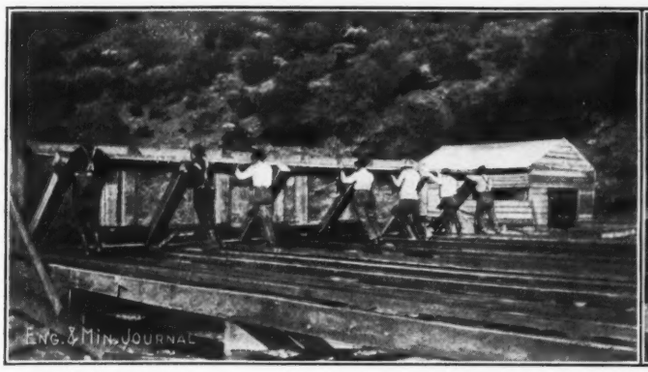
Sicka Mixer and Distributor

on the apex of a conical segment placed in the upper part of a chute. The width of the base of this segment and that of the chute correspond to the desired width over which it is desired to distribute. Thus a uniform layer of suitable width is supplied to the chute by the segment. The rate of discharge to the grate is controlled by the slope of the lower part of the chute being made adjustable. In case the material being fed has a tendency to adhere to the chute, a knocker may be provided.

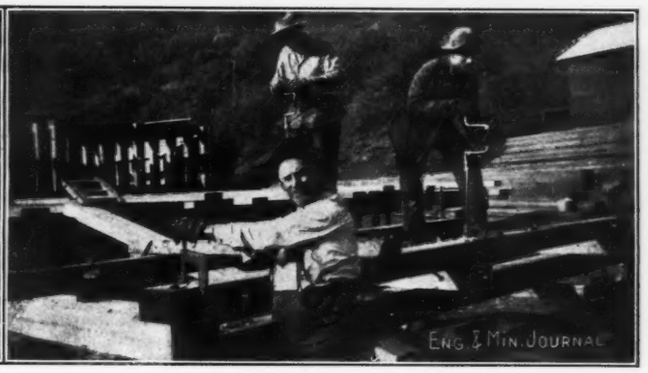
❖

The Value of the Ontario Mineral Production for 1912, as given in a preliminary report of the Bureau of Mines, was $47,471,990, an advance over 1911 of $5,495,193, or 13%. The production of silver in 1912 was 30,322,805 oz.; gold, 89,080 oz.; nickel, 22,421 tons; copper, 11,116 tons; pig iron, 589,593 tons. Portland cement, brick and natural gas contributed largely to the total value of the mineral output.

PHOTOGRAPHS FROM THE FIELD



SETTING FIRST FRAME OF POVERTY BAR DREDGE



BOLTING UP FRAMES

PUTTING IN KEELSONS

STERN FRAME, KEELSONS AND CLAMPS IN PLACE

HAULING KEYSTONE DRILL UP AMERICAN RIVER

OPERATING KEYSTONE DRILL ON POVERTY BAR

(Dredge construction and drilling operations by Eldorado & Placer Counties Gold Mining & Power Co., at Poverty Bar, middle fork of American River, California.)

Prices Received for 1912 Copper

The *Boston News Bureau* has summarized the prices received for the 1912 copper as officially reported by the respective companies and remarks as follows:

There is quite a spread between the high and the low prices received by the various copper producers for their 1912 product. Those selling through the smaller agencies were, generally speaking, the first to "take to the woods" when there were unmistakable signs, late in the year, that the manufacturers on both sides of the water were determined to hold out against the 17¾c. price—which price the big sellers had posted on their doors.

It will be remembered that the American Smelting & Refining Co. and the Amalgamated people for weeks stood firm for the 17¾c. market, long after the smaller agencies were booking business freely at concessions of ⅛@1c. under the 17¾c. level. As the Amalgamated and Guggenheim interests are responsible for the marketing of 60% of the American refinery output, theirs is the difficult task of holding stable, so far as they can, the price level, as against the indiscriminate undercutting of their smaller competitors.

In view of the anxiety of the small producer last fall to book contracts at almost any price obtainable, the big selling agencies did very well indeed to make as good a showing as they did, compelled as they were later on to drop their quotations to 14½c. It requires no selling skill, whatsoever, in times of trade uncertainty, to cut under and take business away from the big agencies. If the United Metals Selling Co. and the American Smelting & Refining Co. were at such times to rush madly into the market and meet the quotations of the little fellows, the market would become utterly demoralized.

We set down in the table below the product sold by some of the large producers which have reported for 1912, together with the prices obtained. Of all the companies, Phelps, Dodge & Co. alone report their quotations on a net-cash, New York basis. Many of the higher averages of the other producers are before freight, selling, and other eastern expenses have been deducted.

Producer	Pounds	Seller	Price c. per lb.
Ray Con	34,674,275	American Sm. & Ref. Co.	15.762
Chino	27,776,088	American Sm. & Ref. Co.	15.64
Nev. Con	63,063,261	American Sm. & Ref. Co.	15.979
Utah Cop	91,366,337	American Sm. & Ref. Co.	15.839
P. D. & Co	148,678,889	Phelps, Dodge & Co.	*15.51
Cal. & Ariz	16,490,229	Phelps, Dodge & Co.	*15.59
Sup. & Pitts	36,618,399	Phelps, Dodge & Co.	*15.65
Old. Dom	16,533,999	American Metal Co.	16.42
East Butte	14,709,460	American Metal Co.	16.692
U. S. Smelting	21,152,620	L. Vogelstein & Co.	16.237
British Columbia	11,146,911	Beer, Sondheimer & Co.	16.66
Miami	32,477,923	Direct	16.582
North Butte	36,480,123	United Metals Selling Co.	16.369
Quincy	20,634,800	Direct	16.24
Mohawk	11,995,598	Stanton	16.08
Cal. & Hecla	67,856,429	Calumet & Hecla	16.65
Centennial	1,196,255	Calumet & Hecla	16.982
Allouez	4,367,964	Calumet & Hecla	16.668
Superior	2,929,182	Calumet & Hecla	16.997
Tamarack	7,298,205	Calumet & Hecla	16.56
Isle Royale	7,782,678	Calumet & Hecla	16.66
Ahmeek	15,950,492	Calumet & Hecla	16.61

*Net Cash, New York.

The quotational average of the JOURNAL was 16.56c. for Lake copper and 16.34c. for electrolytic, net cash, New York.

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Mansfeldsche Kupferschiefer Bauende Gewerkschaft

From the annual report of the Mansfeld Copper Co., Eisleben, Germany, are taken the following items: In 1912 its mines yielded 20,503 metric tons of refined copper against 20,850 tons in 1911, and 3,621,729.65 oz. silver against 3,641,695 oz. in 1911, from 879,675 tons of copper schist.

The company's potash mine, Ernsthall, produced 890,292 metric cwt. of carnallite. Its other three potash mines have also shipped some potash salts, but are not regular producers yet.

The extraction of coal from the Mansfeld colliery, near Langendreer, Westphalia, was 543,585 tons; and the production of coke, 234,033 tons.

At the company's Sachsen concession, near Hamm, Westphalia, two hoisting shafts have been sunk in 13 and 14 months' time, respectively, to a depth of 2500 ft., and both recently reached the coal measures. This will enable the company soon largely to increase its production. The company employed 19,735 men, including officials, at its copper and potash mines, and 2316 men in Westphalia. The high prices of copper in 1912 enabled the company to treble its last dividend.

❋

Grading Analyses and Their Application to Cyanidation

The notable article, published by H. Stadler, on the efficiency of rock-crushing machinery, has given rise to a large amount of discussion and has brought forward many varied ideas on the subject. The subject has been approached by John W. Bell[1], of McGill University, Montreal, who endeavors to deduce some facts which will be applicable and useful in cyanidation, using Stadler's paper as a basis.

The original paper has been so often referred to and quoted, and the Ordinal Number so well known, that it

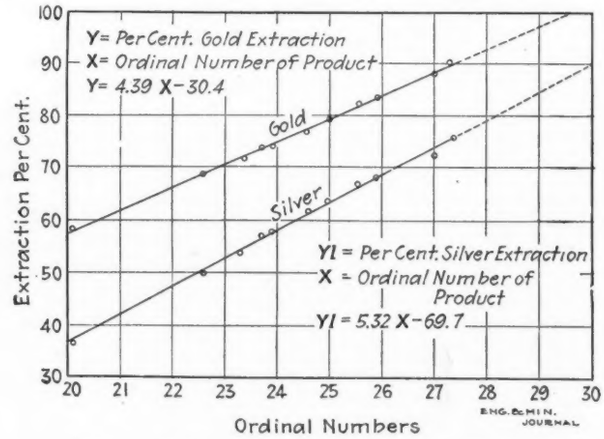


FIG. 1. EXTRACTION CURVE BASED ON ORDINAL NUMBERS

will not be necessary to repeat it at this time. After showing how the Ordinal Number, indicated by N, is obtained for any screen of known square aperture, Mr. Bell proceeds to say that, if then a mill product is sieved on a single screen, the percentage of each size determined and multiplied by its corresponding Ordinal Number, and the quantities thus obtained added together, a composite figure is obtained which is the Ordinal Number of the product. If desired, the average volume of the particles in it can be determined by substituting this volume of N in the formula, $N = \frac{log \frac{1}{V}}{log\ 2}$, and solving for V. Mr. Bell has worked out the Ordinal Numbers for screens and grades used by Messrs. Caetani and Burt, in the test carried on by them at the El Oro mill, in Mexico[2], and Table I shows the result of the calculation.

In the series of screen analyses and sand indices, which mean gold-silver extraction, available and at hand in the Caetani-Burt paper, the data needed to study the relation

[1] "Bull.," Canadian Min. Inst., March, 1913.

[2] "Fine Grinding of Ore by Tube Mills," by G. Caetani and E. Burt, Vol. 37, "Trans.," A. I. M. E.

between volume and extraction are found. By obtaining the Ordinal Numbers of the El Oro screens and grades, it was a simple matter to calculate the Ordinal Numbers of each of the various products made at the El Oro mill, and knowing the corresponding gold and silver extractions obtainable, the results could be plotted on an Ordinal Nmber Extraction basis.

It is stated that the Ordinal Numbers of nine products were calculated and plotted together with their corresponding gold and silver extractions. This established 11 points on each curve; it was at once apparent that the curve took the form of two straight lines, as shown in Fig. 1.

TABLE I. ORDINAL NUMBERS OF EL ORO SCREENS AND GRADES

Mesh	Aperture Inches	Ordinal No.	Grade	Ordinal No.
25	0.0292	15.3	—25 / +40	16.5
30	0.0203	16.9	—40 / +60	18.9
40	0.0167	17.8		
60	0.0098	20.0	—60 / +80	21.0
80	0.0063	22.0		
100	0.0044	23.6	—80 / +100	22.8
150	0.0035	24.6	—100 / +150	24.1
200	0.0026	25.8	—150 / +200	25.2
			—200	28.0

The conclusions were: First, that there is a close relation between volume and extraction. Second, that the extraction does not seem to be proportional to the increase of surface exposed, since the surface exposed increases rapidly from one grade to another, while the increase in extraction appears to be constant for a great interval. Third, that Ordinal Number extractions taken off the curve or calculated by the formula, check with the sand indices calculated by Caetani and Burt, which checked closely with the results actually obtained. Fourth, that a 100% gold extraction is indicated for an $N = 29.7$ product and complete silver extraction for an $N = 39.9$ product. These figures are, however, of merely speculative interest.

Ordinal-Number extractions may be compared with corresponding sand indices in Table 2, in which they are set forth. The relation between volume, surface and extraction was further analyzed by means of the data used by

TABLE 2. COMPARISON OF ORDINAL-NUMBER EXTRACTIONS SAND INDICES

Product	Ord. No.	Sand Index Extraction, % Gold	Ord. No. Extraction, % Gold	Diff.
Feed to No. 4-5 tube mills	20.1	58.4	57.8	+0.6
Stamp mill pulp	22.6	68.9	68.8	0.1
Spitzkasten 1, spigot 1	23.3	71.5	71.9	—0.4
Feed to No. 3 tube mill	23.7	73.6	73.6	0.0
Spitzkasten 1, spigot 3	23.9	74.1	74.5	—0.4
Spitzkasten 1, spigot 4	24.6	77.2	77.6	—0.4
Discharge No. 3 tube mill	25.0	79.4	79.3	0.1
Spitzkasten 1, spigot 6	25.5	81.6	81.5	0.1
Spitzkasten 2, spigot 3	25.9	83.1	83.3	—0.2
Spitzkasten 2, spigot 4	27.0	87.8	88.1	—0.3
Slime to agitation plant	27.3	89.9	89.4	+0.5

NOTE—The ordinal number extractions were obtained by the formula $Y = 4.39 (X) — 30.4$, where Y = % Extraction. X = the ordinal number of the product.

Caetani and Burt in calculating the sand indices. Volume extraction and surface extraction curves were plotted from the data in Table 3. Commencing with the largest particle in Table 3, the volume was halved at each step

TABLE 3. DATA FOR PLOTTING THE CURVE

Product	+40	+60	+80	+100	+150	+200	—200
Av. diam. grain-ins. (d)	0.0190	0.0134	0.0079	0.0052	0.0039	0.0031	0.001
Volume-billionths cu.in.	6850	2400	492	140	59	30	4
Gold extraction	45	53	61	68	75	80	92
Silver extraction	17	28	42	51	59	66	79
Surface exposed	53	75	127	192	256	322	625

(NOTE—The ratio of the original surface to that exposed by crushing has been assumed to be proportional to the number of particles in unit volume multiplied by the square of the average diameter of a particle, $= \frac{1}{d^3} \times \frac{d^2}{1} = \frac{1}{d}$).

and the probable extraction for each volume in this series was obtained from the curve. The results obtained are tabulated in Table 4. Table 5 illustrates how the gold extraction increases for equal increases in surface. Table 4 appears to indicate a more or less even increase in extraction each time the volume is reduced by one-half, and Table 5 does not support the belief expressed by the authors of the El Oro paper that the maximum extraction must be proportional to the surface of the ore exposed by crushing. It is not known whether this relation between volume and extraction applies only to El Oro ore, or is of general application, but if it has general application, there would be substantial reason for introducing the Stadler series of grades into the regular milling prac-

TABLE 4. PROBABLE EXTRACTION FOR EACH VOLUME

Volume-billionths of a cu.in.	Gold extraction	Increase
6850	45%	.....
3425	51	6.0%
1712	54.4	3.4
856	58.0	3.6
428	62.2	4.2
214	66.2	4.0
107	70.2	4.0
54	76.0	5.8
27	80.8	4.8
14	86.0	5.2
7	90.0	4.0
3	92.6	2.6
	Volume reduced ½—11 times	11)47.6
	Average increase =	4.3

tice. The simplification realized by being able to represent a complex screen analysis by a number, is worthy of the attention of the practical mill superintendent. It permits the use of simple charts showing the variations in the size of mill products and the resulting increases or decreases in extraction. In an all-sliming mill there is a classifier overflow of a certain ordinal number which, if maintained, will insure maximum profit. The mill chart for this product should be a straight line as nearly as possible, and any abnormal carelessness in the adjustment of the classifier would be indicated graphically. Occasional or systematic estimates of the ordinal numbers of the mill assay and samples might well repay the small additional expenditure of time and money required.

TABLE 5. INCREASE OF GOLD EXTRACTION WITH SURFACE INCREASE

Surface Sq.in.	Extraction %	Increase in Extraction for each Increase of 100 Sq.in.
100	56.7	.....
200	70.0	13.3%
300	79.0	9.0
400	84.6	5.6
500	88.5	3.9
600	91.2	2.7

Another argument in favor of calculating the Ordinal Numbers of the products is the ease with which two or more can be compared with respect to fineness.

The simplification realized by being able to represent a complex screen analysis by a single number is valuable also in determining the efficiency of screen, classifier, etc. For example, the principal factors which affect the character of the overflow from conical desliming classifiers, are the diameter of the overflow rim, the volume of overflow in cubic feet per minute, the efficiency of the feed plate in destroying the entering velocity of the incoming feed, and the rate of withdrawal from the spigot, although this factor is closely related to the second mentioned.

It is said that experience has shown that the simplest way to study this problem is to sample and measure a number of overflows, determine their ordinal numbers and plot the results for a cone of given diameter.

It is also noted by Mr. Bell that screen analyses made by hand are both antiquated and expensive. For a comparatively small outlay, machines can be obtained which will permit turning out more screen analyses per day than a muscular assayer will do in several days, and the machine screening will be far more reliable and accurate, not to mention the saving in assayer's time and energy.

Dominion of Canada Ore Dressing and Metallurgical Laboratory

A circular from Dr. Eugene Haanel, director, states that the Mines Branch of the Department of Mines has installed at Ottawa a modern well equipped laboratory for purposes of experimental concentration and metallurgical tests with Canadian ores and minerals. The following lists of full-scale and laboratory-size apparatus will convey some idea of the magnitude and latitude of the plant.

The standard-size machinery includes the following: Crushing and screening devices: One Hadfield & Jenks 12x8-in. Blake crusher; one Allis-Chalmers 24x14-in. style C rolls; one Hardinge 4-ft. 6-in. conical ball mill; one Ferraris 6-ft. screen for coarse sizing; one Keedy ore sizer, No. 3, for fine sizing; one duplex Callow screen.

Sampling is provided for by two standard Vezin machines, placed in favorable position to cut out preliminary samples of coarse materials. The fine material will be sampled by an eight-unit system of Flood automatic samplers. Provision has also been made for hand sampling by means of the Jones riffled samplers. All water lines serving standard apparatus will be equipped with Keystone water meters, to enable the keeping of accurate records of water consumption.

Amalgamation and Concentration

For amalgamation and concentration there are: One Allis-Chalmers five-stamp battery, with 1250-lb. stamps, equipped with a 10-ft. tilting amalgamating table, followed by a Pierce amalgamator; the mortar of this mill may be, if so desired, arranged for inside amalgamation; six Callow tanks, 8 ft. diameter, for desliming and settling; two Richards pulsator classifiers, launder type; one Overstrom sand table; one Deister slime table; one Richards pulsator, two-compartment jig; one tandem unit Gröndal magnetic separator, for wet separation of strongly magnetic minerals; one Gröndal magnetic cobber, with dust collector for dry separation of strongly magnetic minerals; one Ullrich four-pole magnetic separator, for either dry or wet separation of weakly magnetic minerals; one Huff electrostatic unit, comprising a standard generator and two laboratory-size separators.

Laboratory Apparatus

The laboratory or small-scale apparatus includes: One Sturtevant 2x6-in. laboratory crusher; one Sturtevant 8x5-in. laboratory rolls; one Sturtevant 12x24-in. laboratory screen; one Braun planetary pulverizer; one Abbe six-jar pebble mill; one gyratory screen (Hoover type), for making dry screen analyses with nested screens; one Richards combined laboratory pulsator jig and classifier, with glass side; one Gröndal laboratory magnetic separator, for either dry or wet separation of strongly magnetic minerals; one Wilfley table, 24 in., laboratory size; one laboratory cyanide plant of 200 lb. capacity, consisting of a Parral agitator and air pump, with the necessary solution, zinc and sump tanks; two laboratory filter presses; one complete set of I. M. M. standard screens; one complete set of Tyler standard screens, after the Rittinger scale.

The installation of an experimental roasting and sintering plant will be undertaken some time during the year.

The plant will be operated free of all charges, including assays necessary for test purposes, on Canadian ores, under the following conditions. (a) Samples must be bagged and delivered to the plant free of all transportation and unloading charges. (b) For small-scale tests, not less than 200 lb. will be accepted. For large-scale tests, not less than five tons will be accepted. (c) All testing products are to become the property of the Mines Branch, unless otherwise arranged before commencement of tests. (d) Reports of tests will be incorporated in the publications of the Mines Branch, but single copies will be given to owners of samples when their tests are completed.

Under ordinary conditions tests will be made by the Mines Branch officials, but arrangements may be made whereby engineers or other competent persons may supervise their own experiments. It is expected that the plant will be ready for operation by the first week in July, 1913. All communications regarding arrangement of tests should be addressed to Eugene Haanel, PhD., Director, Mines Branch, Department of Mines, Ottawa.

California Oil in March

The net production of petroleum in all fields in California in March (31 days) was 7,564,056 bbl., an increase over February (28 days) of 762,867. The increase in daily average net production was only 1102 bbl. The shipments in March were 7,355,924 bbl., an increase over February of 829,844, or an increase in daily shipments of 9213 bbl. The stocks on hand at the end of March amounted to 48,156,980 bbl., an increase over February of 188,486. The field records for March show 422,318 bbl. consumed as fuel, 40 new rigs, 347 wells drilling, 381 wells on which drilling was suspended, 64 wells completed, 5962 wells producing, 906 wells capable of producing but idle, 16 wells abandoned.

CALIFORNIA OIL PRODUCTION BY FIELDS

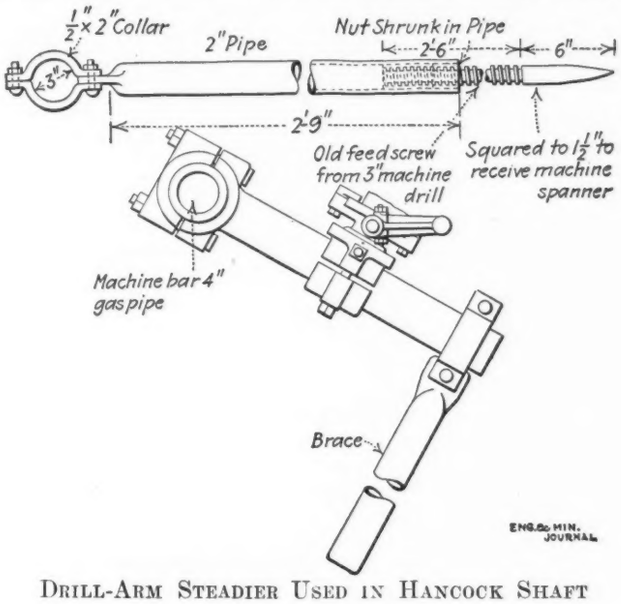
District	Bbl.
Fresno County—	
Coalinga	1,546,065
Kern County—	
Midway	2,373,604
Kern River	817,786
Maricopa	488,136
Lost Hills-Belridge	375,550
McKittrick	364,492
Total Kern County	4,419,568
Santa Barbara County—	
Santa Maria-Lompoc-Cat Cañon	389,118
Summerland	4,350
Total Santa Barbara County	393,468
Southern Fields—	
Olinda-Brea-Puente	534,824
Coyotes-La Habra	272,576
Salt Lake	223,823
Ventura	74,689
Whittier	58,117
Los Angeles	31,842
Newhall	9,084
Total Southern Fields	1,204,955
Total All Fields	7,564,056

DETAILS OF PRACTICAL MINING

Steadying Leg for Rock Drill Bars

In sinking the No. 2 Hancock shaft in the Michigan copper country, the rock drills were mounted on arms carried by a regular shaft bar with a single screw at the end. On each arm a collar was used carrying a leg to steady the bar under the hammer of the three machines which were used at one time, and which otherwise would have made it difficult to keep the bars tight.

The details of this steadying leg, with the collar by which it is attached to the arm, are shown in the accompanying illustration. The device consists simply of a collar with a pipe fastened to it, from the lower end of which extends a screw leg made from an old machine feed-screw. The end of this screw leg is drawn down to a sharp point, which is firmly braced and screwed out, from time to time, so that the machine is kept braced tightly from the ground and cannot swing. It is usually the surging of the machine that loosens the bars. This device steadies the arms upon which the machines are directly mounted, and therefore the large shaft bar receives far less jar and vibration than would otherwise be the case.



DRILL-ARM STEADIER USED IN HANCOCK SHAFT

❖

Unreliable Drawing Paper

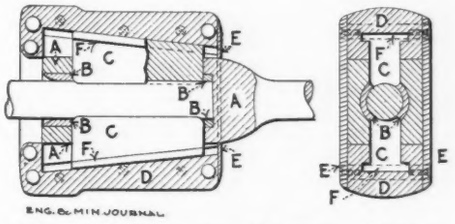
The greatest difficulty encountered in the topographical survey of Cincinnati, in which plane tables were employed for plotting, lay in the tendency of the plane-table paper to swell and shrink, says Hugh T. Mitchell, in a paper read before the Engineers' Club of Cincinnati (abstr. *Engineering News,* Apr. 3, 1913.) The paper should have had two years of seasoning. Since such could not be procured, the best possible was substituted, but parts of it went into the field within a month after mounting, and changes of seven or eight linear parts in 1000, due to varying humidity, were found in some cases.

Engineers and draftsmen who have unrolled heavy paper and plotted in the afternoon, and found the measurements entirely incorrect the following morning, will appreciate such difficulty. It is connected with one of the main objections against the use of the plane table; the necessity of intrusting all notes and data to a single sheet of paper. As stated in the paper just quoted, all errors in the field were swallowed up in the tendency of the paper to expand and contract. Of what avail then is accuracy in the field? Furthermore, there is no convenient way to duplicate a plane-table record except by tracing, which is unreliable and inaccurate. Whereas, if transit notes have been taken, any number of identical maps may be made at any time on paper that may be obtained and properly seasoned.

❖

Dabadie Wedge Drill Chuck

A chuck for rock drills, acting on the wedge principle, has been devised by John L. Dabadie, Stockton, Calif. (U. S. pat. 1,044,029.) The end of the piston *A* has a central hole in which is the usual bushing *B,* to receive the shank of the drill steel. This bushing, as well as the chuck, is slotted longitudinally on top and bottom. In these slots the wedge pieces *C* operate so as to bear on the drill shank and hold it when in operation. The portions of *C* bearing on the shank are concave to fit the shank. The wedge pieces and chuck are encased by the top and bottom pieces *D,* and the side pieces *E,* bolted and pinned together as shown. The pieces *D* are slotted to correspond to the slots in the chuck and bushing, and have their slots spread at the top to carry crossheads *F* of the wedges *C.* These slots are longer than the contained wedges *C* so as to permit motion, while the slots in the chuck and bushing are fitted to the wedges. In operation the drill is inserted and at the end of the first stroke, the casing composed of *D* and *E* is thrown forward by inertia and by means of its wedging action on *C,* forces this latter against the drill shank. Subsequent blows increase the binding effect. The drill can be released by driving the casing back with a hammer. The use of the two wedge pieces instead of one is rather out of the ordinary.



WEDGE CHUCK FOR MACHINE DRILLS

Transmission Line Conductors

The size of the line conductors for electrical transmission depends on both economical and electrical considerations. In determining the size, recourse is had to Kelvin's law, which states that "the most economical area of a conductor will be that for which the annual interest on the capital investment equals the annual cost of the energy lost in the line," says E. K. Lof, in *Engineering Magazine,* March, 1913. With steel towers it is usual to string the conductors with a high tension, to reduce sag and tower height, and with rigid towers a safety factor of two is used, that is, the stress at the worst load condition is one-half the ultimate strength of the conducting material. The worst load condition is assumed to occur at 0° F. with an actual wind velocity of 56 miles per hour, equivalent to 8 lb. pressure per square foot on the projecting area, and with an ice covering ½ in. thick. The maximum temperature is considered to be 130° F. and the cables should be supported so that at this temperature the clearance between the lowest conductor and the ground is equal to 25 or 30 feet.

The interaxial distances between the various conductors depend upon the voltage and the length of spans. For long spans with large sags there may be danger of the conductors swinging together, unless spaced well apart. In United States practice the ratio of the spacing in feet to the voltage carried is about 1 to 11,000, that is, for a voltage of 33,000 the spacing of the line conductors is 3 ft. and for 140,000 volts the spacing is 12 ft. In determining voltage, care must be exercised that the critical voltage of corona is not reached. Corona is that point at which the air at the surface of the conductor breaks down as an insulating medium and becomes luminous.

Line conductors may be made of either copper or aluminum. The conductivity of aluminum is about 63% and the weight about 30% of that of copper, thus an aluminum conductor of the same length and conductivity weighs about 48% of a copper one and the cost of aluminum can be twice that of copper without increasing its cost as a conductor. However, as prices are quoted, aluminum is usually more expensive to use in the United States, although the reverse may be true in Canada. Both copper and aluminum conductors are now generally stranded and it is claimed that aluminum conductors are reliable and free from the breakages that were frequent when they were made solid. For long spans, stranded steel cables are generally selected or else duplex conductors which consist of a steel core surrounded by copper. The object of this is to gain strength and at the same time retain conductivity.

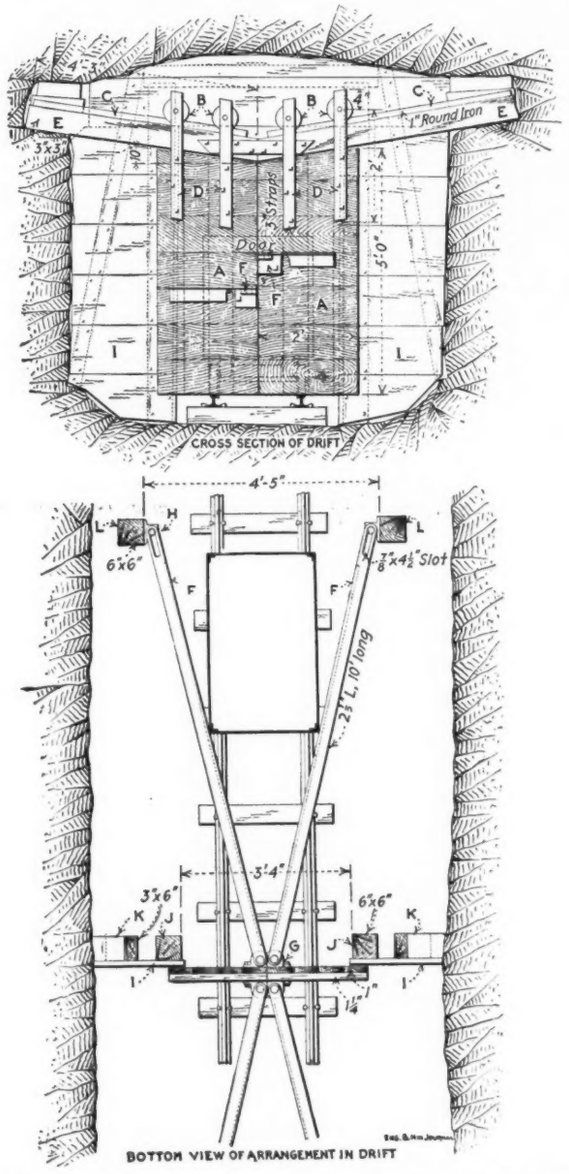
The transmission conductors should preferably be transposed so as to nullify the effect of the mutual inductance by producing in one section of the line an effect opposed to that in another. Special arrangements of the crossarms are generally needed for this purpose.

It is advisable to erect a ground wire, preferably a ⅜-in. stranded and galvanized-steel cable, above the line conductors to act as a protection against lightning. Usually one wire is installed rigidly clamped to the top of the tower and offers the additional advantage of a mechanical support in tying together the towers. Sometimes two ground wires are provided placed above and at 45° out beyond the outer conductors. This method affords good protection, since the wires will tend to discharge charged snow flakes or rain drops which may drive against the line from an angle at either side. Ground wires, experience has shown, are well worth the extra cost.

Automatic Door for Ventilation Control

By H. S. Gieser*

At the Jupiter, which is one of the deep-level mines in the Germiston area of the East Rand, there are two shafts, the Howard and the Catlin, both of which are part vertical and part inclined. The bottom of the Catlin is 5040 ft. vertically below the surface and at these great depths the heat is excessive. Mechanical ventilation is employed and to guide the air through the stopes, automatically operated doors are provided on the levels, approximately as shown in the illustration.



Automatic Door to Control Ventilation through Drift

*Mining engineer, P. O. Box 1180, Johannesburg, S. Africa.

Referring to the drawing, the sliding door is made in two leaves *A*, which slide laterally by means of the sheaves *B* on the 1-in. inclined round irons *C*. The doors are made of a layer of 1-in. vertical boards and a layer 1¼-in. horizontal boards and are of the dimensions shown. The sheaves are six inches in diameter and carry the doors by iron straps *D*, 3x28 in. The round irons are carried on timber pieces *E*, 3x3 in. by 4 ft. 3 in., inclined from the center of the drift at an angle of 10°. As the doors are forced open, the sheaves roll out and up on the round irons against gravity and, when released again by the passage of the car, they slide together by their own weight.

The doors are actuated by the four angle irons *F*, set two on each side so that cars from either direction will open the doors. Each angle has one end pivoted on the inner edge of the door at *G*, and the other end slotted and moving on a fixed pin at *H*. They are set at a height to catch a car body, and on each side of the door one rail is slightly higher than the other. The car entering between them forces them apart and opens the doors, and as it passes, allows them to close in a similar manner. The angles are 2½x2½ in. and are 10 ft. long, set with one outer side up and one toward the center of the drift. The slot at *H* is ⅞x4½ inches.

The drift, approximately seven feet wide, is closed for the most part by a 1-in. wood brattice *I*, only enough opening, 3 ft. 4 in., being left for the door to cover, as will admit a car. This opening is contained in a frame of 6x6-in. stuff *J*, to which, as well as to slanting 3x6-in. pieces *K*, the 1-in. brattice is fastened. The pins on which the angles slide are carried by a frame *L* of 6x6-in. material.

The Effect of Knots on Timber

The accompanying table sums up the results of a series of tests made by the U. S. Forest Service, and published by them in *Bull.* No. 108. The tests were made to determine the effect of knots of different classifications on the crushing strength of certain varieties of timber. It will be noticed that in some cases the presence of knots seems actually to increase the strength.

RATIO OF RESULTS OF STRENGTH TESTS ON KNOTTY TIMBER TO RESULTS ON CLEAR TIMBER, STRENGTH OF CLEAR TIMBER TAKEN AS UNITY

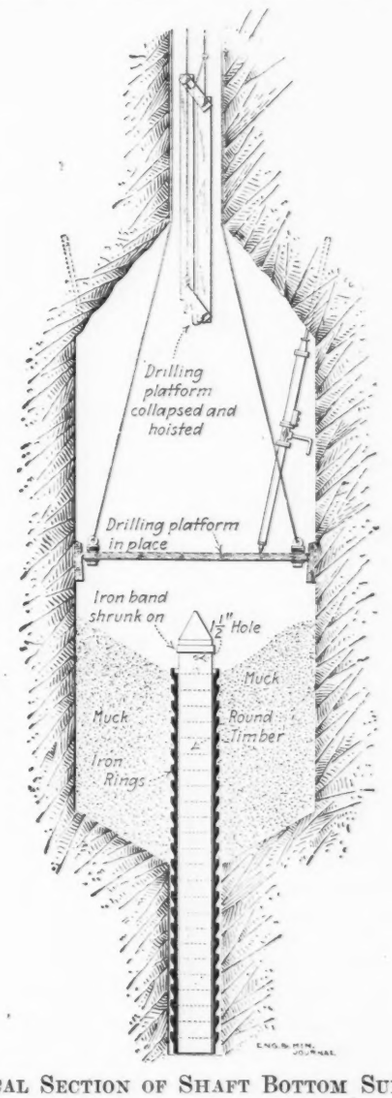
	Compressive Strength at Elastic Limit per Sq.In.	Crushing Strength at Maximum Load per Sq.In.	Modulus of Elasticity per Sq.In.
Douglas fir:			
Pin knots	0.95	0.94	1.06
Standard knots	0.87	0.86	0.90
Large knots	0.78	0.78	0.71
Western larch:			
Pin knots	1.12	1.04	1.19
Standard knots	0.98	0.89	1.00
Large knots	0.98	0.85	
Western hemlock:			
Pin knots	0.96	0.97	1.00
Standard knots	0.94	0.91	0.97
Large knots	0.86	0.83	0.81

Pin knots are defined as sound knots ½ in. or less in diameter. Standard knots are defined as sound knots ranging from ½ to 1½ in. in diameter. Large knots are also sound knots from 1½ in. in diameter, up.

Water Wheels of the Pelton Type for a Head of 2800 ft. were installed in a hydro-electric plant at Arniberg, Switzerland. The buckets, according to the "Engineer," Feb. 28, 1913, are carried on the periphery of a disk of forged steel, bolted to the end of the generator shaft. They are held by a circular forged-steel plate riveted to the disk, no provision for individual replacement being necessary on account of the extreme purity of the water.

Shaft Sinking with Core Drill

An ingenious method of shaft sinking which embodies drilling a large hole, preferably by a shot drill of the Terry type, and subsequently enlarging it by a combination of methods, is proposed by Olin S. Proctor*. The operation would be conducted in lifts of 100 ft., or slightly more. Beginning at the surface, the shaft is excavated by hand methods to a depth of 8 or 10 ft., and timbered. From the bottom of this shaft, approximately in its center, a vertical hole is drilled for 108 ft. This is limited in diameter to a minimum of 20 in., as



VERTICAL SECTION OF SHAFT BOTTOM SUNK AND ENLARGED BY PROCTOR METHOD

the next operation consists of lowering a man with a small hammer drill to put in a series of pop holes at a height of six ft. above the bottom. The bucket is lowered into the bottom of the hole, and together with the lower six feet of hole, is filled with water for protection. The cable is protected by two halves of a pole, 6 in. by 12 ft., grooved through the center and wired on. The first round is then shot and caught in the bucket for removal.

Breaking out the shaft with small rounds to its full dimensions is continued, the material being caught in

*Proctor Engineering Co., 150 Nassau St., New York.

the bucket as described, until there is attained a height of eight feet, or 14 ft. above the bottom. A casing of iron or steel rings is then built up as shown. Above the 6-ft. length of bore hole left at the bottom, these are steadied by a round timber, set inside, having a pointed upper end, bound with an iron band shrunk on, and pierced with a 1½-in. hole for attaching a rope. This should fit rather snug in the rings. It also plugs the rings against filling with muck by the blasting; hereafter the bucket is operated inside the rings and should be of suitable dimensions for that purpose.

From this point up, the hole is enlarged by combining two methods, somewhat resembling the carrying up of two stopes. The rock immediately adjacent to the hole is broken out without drilling. The bottom of the hole is closed with a plat made of two 1x12-in. boards about two feet long cleated together, which is held up by common wire or cheap cable. This is covered with muck or sand to a depth of 3½ to 5 ft., a ring of powder placed against the rock and about five feet more of tamping placed on the powder. On blasting, the muck falls into the open space surrounding the rings, being kept from the inside by the timber. Care is taken not to break more than will fill the space to the top of the rings. In mucking, the timber is pulled out, the bucket lowered into the space it occupied and filled for hoisting by removing the rings one at a time, allowing the muck to run in. A man is necessary for this work, but little actual mucking need be done.

The shaft is next broken to its full dimensions by drilling from a movable platform. This platform is collapsible, consisting of two side timbers, 4x8 in., and two-end timbers, 3x12 in., cut to a length somewhat smaller than the dimensions of the rock section. The corners are fastened by eye-bolts, with washers to allow free motion, and nuts securely fastened. The platform is raised and lowered by two ropes attached as shown in the drawing, which represents the platform in use and also hoisted into the hole for safety during blasting. On lowering, it should open automatically, and is then wedged in the shaft for actual drilling. The tools and men on the platform should be attached by ropes to prevent accident by falling. The handling of the muck is the same in this case as that previously described.

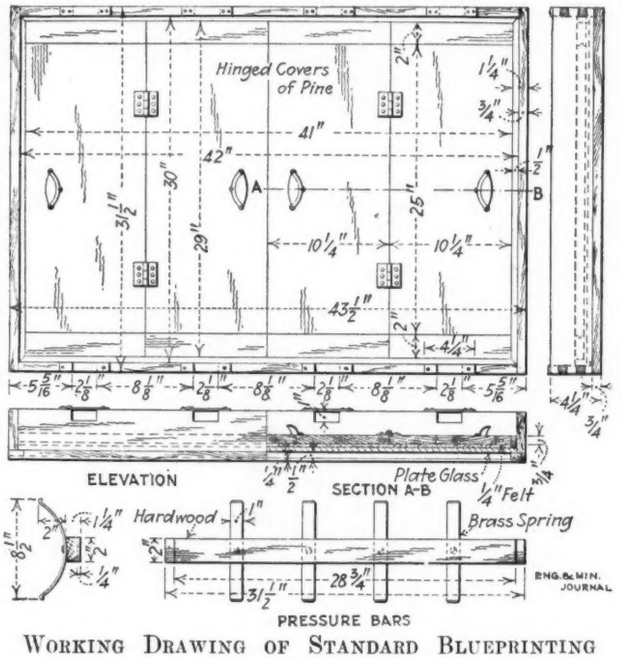
It is urged for the system that hand mucking is eliminated, overhead drilling rendered possible, and while the operation is limited to conditions where the inflowing water can be bailed, this is an operation easily performed and as sinking is carried on in 100-ft. lifts, most of the water can be shut off at the level above. The two enlarging operations alternate, but hoisting can be carried on simultaneously with the drilling. Apparently no provision for timbering is made, but temporary sets could be run up if necessary, and replaced when the lift was completed.

Liquefied Gases as Explosives

Liquid air, and more especially liquid oxygen, are being experimented on in Germany as mine explosives, according to *Echo des Mines*, 1913, p. 476. The latter, mixed with aluminum powder, and detonated, forms an explosive about 2½ times as powerful as black powder, from which there can be no deleterious fumes, as the only products of an explosion are oxygen and alumina.

Blueprint Frames

The accompanying illustration is a working drawing of a blueprint frame for prints up to 29x41 in. in size. This is a standard type of commercial frame, but circumstances may arise where it becomes necessary or desirable to make such a one at the mine. The most important and expensive single item entering into its construction is the plate glass. This is usually of a gage approximating ¼ in., but for a frame of this size, it should be heavier rather than lighter. The frame proper should be made of hard wood preferably, and this should be as perfectly seasoned as possible; for if even a little warping takes place, the brittle glass will be cracked. The same consideration makes it imperative to protect the wood from absorption of moisture, which is also capable of distorting the frame and breaking the glass. Frames of large size, often 3½x6 ft., are necessary for handling mine maps, and the greatest difficulty is experienced with ordinary frames of this size, in procuring uniform and



WORKING DRAWING OF STANDARD BLUEPRINTING FRAME

close contact of tracing and paper. A pad which will not eventually wrinkle and give blurred prints, is not easily obtained. To avoid this, the vacuum contact or the cylindrical surface glass is adopted, but their cost is often prohibitive for a small mining company, or at least is thought so. As a matter of fact any cylindrical surface should be available. By placing the paper and tracing outside, the necessity of a transparent material is avoided.

To avoid accident and save time, it is advisable to have large frames mounted to run either on tracks or on a floor and to revolve on a horizontal axis and if possible, on a vertical axis, thus obtaining the full value of the sun's light at any time. Such a mounting frame can usually be constructed out of mine scrap iron or new wood or iron. A small unmounted frame similar to the one here illustrated, is also convenient for handling small tracings. The mines that are of a size to afford the large cylindrical-glass, arc-light printing machines are fortunate, but scarce.

DETAILS OF METALLURGICAL PRACTICE

Fuller's Rule for Concrete Quantities

The simplest rule for determining the quantities of materials for a cubic yard of concrete is one devised by William B. Fuller. It is expressed in words in Taylor and Thompson's "Concrete Costs," as follows:

Divide 11 by the sum of the parts of all the ingredients and the quotient will be the number of barrels of portland cement required for one cubic yard of concrete. The number of barrels of cement thus found, multiplied respectively by the "parts" of sand and stone, will give the number of barrels of each required for one cubic yard of concrete and multiplying these values by 3.8 (the number of cubic feet in a barrel), and dividing by 27 (the number of cubic feet in a cubic yard), will give the quantities of sand and stone, in fractions of a cubic yard, needed for one cubic yard of concrete.

To express this rule in the shape of formulas: Let

C = Number of parts cement;

S = Number of parts sand;

G = Number of parts gravel or broken stone.

Then,

$$\frac{11}{C+S+G} = P = \textit{number bbl. portland cement required for 1 cu.yd. of concrete}$$

$$P \times S \times \frac{3.8}{27} = \textit{number of cu.yd. of sand required for for 1 cu.yd. of concrete}$$

$$P \times G \times \frac{3.8}{27} = \textit{number of cu.yd. of stone or gravel required for 1 cu.yd. of concrete}$$

The accompanying table is made up from Fuller's rule and represents fair averages of all classes of material.

MATERIALS FOR ONE CUBIC YARD OF CONCRETE

Proportions	Cement barrels	Sand cu.yd.	Gravel or stone cu.yd.
1 : 1½ : 3	2.00	0.42	0.84
1 : 2 : 4	1.57	0.44	0.88
1 : 2½ : 5	1.29	0.45	0.91
1 : 3 : 6	1.10	0.46	0.93
1 : 4 : 8	0.85	0.48	0.96

If the coarse material is broken stone screened to uniform size, it will contain less solid matter in a given volume than an average stone, and about 5% must be added to the quantities of all the materials. If the coarse material contains a large variety of sizes so as to be quite dense, about 5% may be deducted from all of the quantities.

Removing Foundation Bolts

An ingenious method of removing foundation bolts when the situation is such that the machine cannot be lifted, is described by Charles W. Mortimer in *Power*, Apr. 15, 1913. It was necessary to remove a motor over which a ceiling had been built so close that the machine could not be lifted, but had to be slid off its foundation. It happened that wood sleepers had been interposed between the motor frame and the foundation. In these sleepers horizontal holes were bored to each bolt. A 220-volt circuit was tapped and connected to the top of the bolt and also to a small iron bolt set in the hole in the wood. This bolt did not touch the foundation bolt, but an arc was formed near the tapping point by breaking the contact, and a 30-ampere current maintained for three minutes, which made the foundation bolt red hot at that point. Then by tightening the nut the rod was severed with a few blows.

Natural Draft Water-Cooling Tower

In localities where water is scarce it becomes necessary to cool it and use it again for condensers, air compressors, and gasoline or oil engines. A device designed for this purpose is the Wheeler-Balcke cooling-tower, shown in the illustrations. The warm water, according to *Power*, Mar. 25, 1913, enters through the water inlet, Fig. 1, is discharged into a trough made of cypress planks 1½-in. thick, and flows from this into lateral gutters, which in turn distribute it over the entire area of the tower by means of iron pipes arranged at equal intervals in the gutter lengths. The water falling from these pipes impinges upon galvanized steel splash-plates, which break it up into a fine spray. In the form of spray the water then drops upon the triangular cooling laths below, which are arranged in zigzag tiers. The zigzag arrangement insures the breaking up and turning over of the

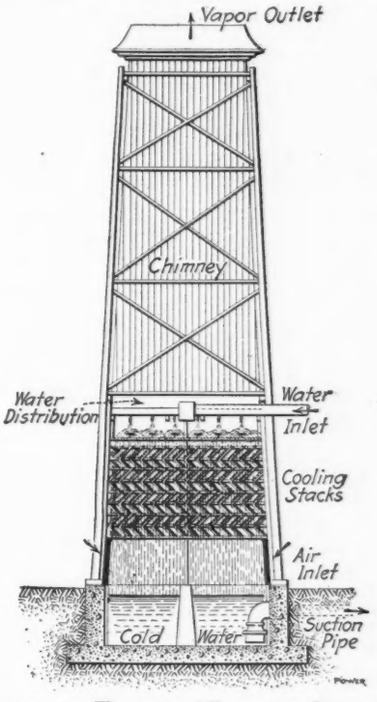


FIG. 1. SECTION OF TYPICAL WHEELER-BALCKE COOLING TOWER

water, without its presenting high resistance to the rising column of air. The air admitted at the bottom is drawn up by means of the wooden chimney, constructed upon the top of the cooling stack, carrying with it the vapor, the evaporation of which has cooled the water. The cooled water is caught in the concrete tank below. In large towers a multicellular design is employed for the purpose of introducing the air at different points and preventing the concentration of the draft and the consequent cooling effect at the edges of the tower. Fig. 2 shows an actual installation, capable of cooling 72,000 gal. per hr., at the Plano Works of the International Harvester Co., in West Pullman, Ill. This tower operates in

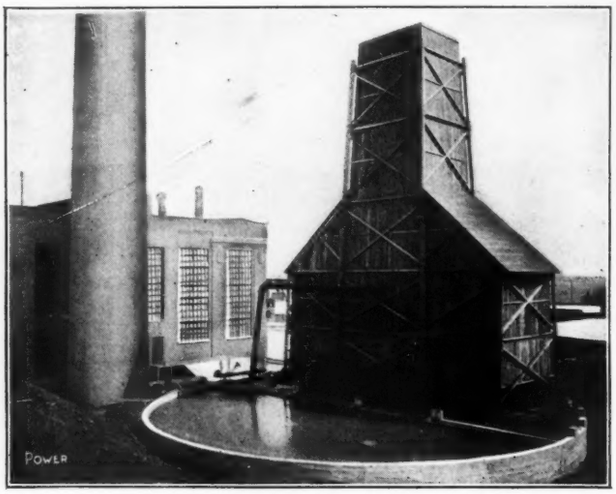


FIG. 2. COOLING TOWER INSTALLED

connection with jet condensers. The water is cooled about 20° F. in passing through the apparatus, the degree of cooling varying with atmospheric temperature and humidity.

Method for Calibrating Anemometers

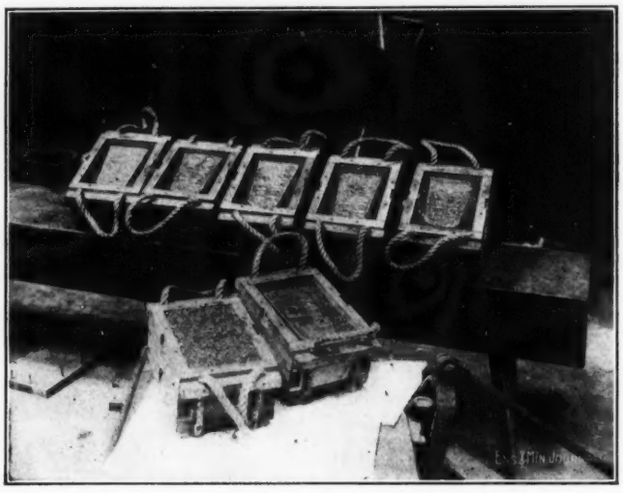
A method of calibrating an anemometer, described by E. F. Learned in *Engineering News*, Apr. 24, 1913, consists in attaching the instrument to a projecting support on a bicycle. The supporting board was far enough in advance of the wheel not to be affected by the air eddies caused by the rider and machine in motion. Two strong threads fastened to the starting lever of the instrument were carried back along the top of the board through wire loops to the handle bars, thus enabling the rider to start and stop the anemometer at will. An assistant took the time with a stop watch.

Lead Burning with Acetylene

Lead burning with the oxyacetylene burner is comparable as regards looks and durability with lead burning which has been done with hydrogen, while the length of time necessary for the work is considerably reduced (*Echo des Mines*, Apr. 21, 1913). Thus, for burning on flat surfaces between lead sheets 3 mm. thick, the speed was as follows: One meter in 3 min. 45 sec. with a flame using 15 liters of acetylene per hour; one meter in 2 min. 39 sec. with a flame using 20 liters of acetylene per hour; one meter in 1 min. 5 sec. with a flame using 25 liters of acetylene per hour. It is essential in order to attain quickness of working, to scrape clean the edges to be soldered, and to use as soldering sticks bars which have been cast only a little time before using.

Shipping Mount Morgan Bars

The Mount Morgan mine in Queensland, Australia, follows a system of shipping its gold bars somewhat



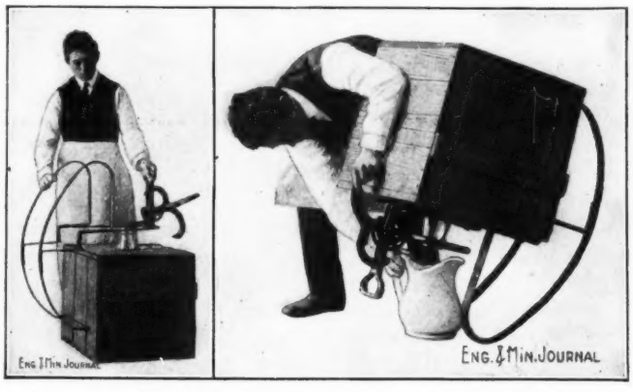
PACKING MOUNT MORGAN GOLD BARS

different from the usual one. As shown by the accompanying illustration, the shape of the bar is unusual and the company name and the fineness of the bar is imprinted in the side.

The bars are put in wooden cases, packed with sawdust or excelsior, and the top screwed on. The cases are substantial and rather elaborately made, as may be seen, and are returned from the refinery to the mine for further use. They are costly and are used repeatedly.

A Carboy Inclinator

A contrivance for handling carboys is illustrated in the accompanying engraving. By a single movement it is clamped securely to the package and it may easily be inclined on the rockers to any desired degree, the con-



INCLINATOR FOR POURING FROM A CARBOY

tents of the carboy being received in any desired vessel without any spilling or splashing. One inclinator will serve as many carboys as desired as it is adjusted in a moment. It is durably made, and is manufactured by the Carboy Inclinator Co., of New York.

NOTES FROM CURRENT LITERATURE

Iron Deposits of Tennessee

Various types of iron deposits are found in Tennessee, according to *The Resources of Tennessee*, April, 1913. On the east side of the Appalachian Valley, and on the western rim of the Central Basin, are found deposits of brown or limonite ores, formed in general, by the decay of the Knox dolomite and the accumulation of the iron by the percolating waters. A different type of limonite deposit occurs in Lawrence and Wayne Counties, where the mineral is found mixed with a jumble of gravel, angular rock, sand and clay. The suggested origin for this type is deposition from iron-bearing springs. The orebodies at Ducktown were originally worked for iron, the gossan there being the result of superficial oxidation of pyrite deposits. In the region between the Holston and French Broad Rivers, east of Knoxville, deposits of red iron ore, occur in the Tellico formation, which consists of shale, sandstone and lime. Two or three comparatively thin horizons of ore are separated by beds of shale and sandstone. The rocks are ferruginous and the formation of the deposit is attributed to the removal of lime carbonate by solutions, leaving a residue of siliceous iron. Finally, ores of the Clinton type are found occurring in the Rockwood formation, which is the equivalent of the New York Clinton. These beds outcrop along the eastern base of the Cumberland plateau, and are two to four feet thick. The Clinton ores are generally supposed to be original depositions enriched in some portions by the removal of soluble carbonates.

⁂

Sanitation of Mining Camps

The fact that mining camps are usually established in remote districts, where at first modern conveniences are not obtainable, and the fact that their generally temporary nature renders it inexpedient to expend large sums on the first cost of sanitary installations, results in sanitation being neglected, and mining camps are therefore notoriously subject to the ravages of typhoid and other diseases. Chas. H. Hair, in the 1912 *Transactions* of the Canadian Mining Institute, outlines certain precautions that should be taken. The water-supply of a camp is particularly liable to infection in an evergreen country, where the high percentage of organic matter in the water is an excellent culture medium for bacterial growth. When there is any suspicion of the water being contaminated, it should invariably be boiled for drinking and cooking purposes. Complete purification can be obtained by treatment with chloride of lime. A teaspoonful dropped into a teacup of water and diluted to four teacups altogether, makes a suitable solution for purifying purposes, a teaspoonful of the whole quantity being sufficient for two gallons of drinking water. The water-supply should be protected against bathing or drainage. Garbage can be disposed of by feeding it to hogs, but the liquid portion should be carried off by a drain to a tank lined with cement or cedar and connected with subsoil drains. Manures, cans, bones, etc., should be burned. Sewage disposal is of the greatest importance. The old earth or pit closet is no longer permissible. Under primitive conditions, a box closet may be used, but as soon as a water-supply under pressure is obtainable, the flush closet and septic tank is the only system to be tolerated. Bunk houses should be subdivided to permit of adequate ventilation and to limit the spread of infectious diseases. The ravages of the house fly should be reduced to a minimum by maintaining conditions of absolute cleanliness thus giving them no opportunity to breed. Screens and poisons within the house may also be of some advantage.

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Larder Lake Geology

The oldest formations of the Larder Lake district are the Keewatin and the Pontiac schist, areally distinct and with their relative ages indeterminable. The Keewatin, according to Morley E. Wilson (Memoir No. 17-E., Canadian Geological Survey), consists of greenstones and greenstone schists, generally of volcanic origin, on which were deposited Larder slates and ferruginous dolomites, the whole intruded by porphyry, rhyolite and aplite. The Pontiac schist is a metamorphosed acid sedimentary. These two formations are intruded by an acid batholith, which on its borders forms a complex of a variety of rocks. This igneous intrusion may have produced the dynamic metamorphism of the older rocks. It took place in Laurentian time, and was followed by a period of denudation and later deposition of the clastic Huronian sediments. Denudation again ensued and intrusion by diabase, gabbro and syenite porphyry. A large number of mineral occurrences exist, the chief prospecting interest centering in the auriferous quartz stringers in the Keewatin ferruginous dolomite, where two systems of intersecting veinlets become so numerous in places as to form a stockwork.

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Uses of Zirconia

Probably the largest field for the utilization of zirconia is its employment as a refractory material, says the *Bulletin* of the Imperial Institute, January-March, 1913. Crucibles molded from a mixture of 90 parts of zirconia with 10 parts of magnesia, made into a paste with 10% of phosphoric acid, are said to be extremely resistant to heat and are practically unaffected by molten alkalis or strong acids. In another method, starch is used as the binder, and the crucibles after being dried at a low temperature for several days are fired in a Hempel electric furnace at a temperature of 2000 to 2300° C. Zirconia crucibles are now being manufactured in Germany.

Owing to its low coefficient of expansion, wares made from zirconia can be plunged red-hot into water without risk of fracture. The suggestion has been made that zirconia could be used in the ceramic industry, but for this

purpose cheap zirconia, free from iron, would be required. The use of small quantities of zirconia in the manufacture of a glass known as siloxide has already been given in the JOURNAL, Apr. 20, 1912. The use of zirconia as a pigment has been patented. It is also used as a component of the glower in the Nernst lamp and has been tried as a substitute for thoria in incandescent-lamp mantles. It is also stated to be used instead of bismuth salt for defining X-ray photographs of the intestines. Basic zirconium acetates have been patented as a weighting material for silk. Ferrozirconium, containing about 20% of zirconium, is made in the electric furnace and employed to a small extent in the refining of steel, the quantity used being about 1% of the steel treated. Zirconium carbide was at one time used for incandescent-lamp filament, but has been displaced by metallic filaments.

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Point of Precipitation from Magmatic Solutions

At the conclusion of an article on the hot springs of Wagon Wheel Gap, Colo., where thermal springs occur in conjunction with some mineral deposits, W. H. Emmons and E. S. Larsen, in *Economic Geology,* April-May, 1913, remark that probably there is no deposit of sinter or tufa in the world being successfully exploited at present for precious metals, and that the conclusion seems inevitable, assuming most of the ores of gold, silver and copper to have been deposited by thermal waters, that the rising waters deposit the greater portion of their load of these metals in the deeper zones, which are exposed to man only after the sinters and more or less of the surface rock below them have been eroded. From the standpoint of physical chemistry, the theory is plausible that maximum deposition takes place well below the surface; for chilling and mixing with partly oxidized vadose water would tend to precipitate the metals out of the alkali choride, alkali-carbonate or alkali-sulphide solutions. The depth of this precipitating point cannot be determined, and probably many orebodies of copper and of gold were formed at depths well below the normal active meteoric circulation. With precipitation thus begun at greater depths the precious metal would be completely thrown down when the thermal waters met the cold circulation. Iron, however, may remain in the solution and deposit at the surface. Under some conditions the same may also be true of copper.

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The Ground Waters

Views on the underground waters have been progressing in the last decade or more and new evidence has been brought to light. A general summary and concise statement, says James F. Kemp (*Bull.* A. I. M. E., April, 1913), may therefore not be without interest. The tendency to attribute more and more importance to the magmatic waters, as opposed to the meteoric waters and the connate waters (i.e., waters deposited with the rocks in which they are found), received somewhat of a check when Paul Brun, of Geneva, Switzerland, announced that there was no water in the gases of Vesuvius nor in those of Kilauea. Somewhat similar evidence was the conclusion of Doctor Goldschmidt that the iron in the contact zones near Christiania, Norway, was not introduced through the agency of steam but through that of chlorine. Brun's conclusions, however, were disproved by the recent success of the representatives of the Carnegie geophysical laboratory in condensing unmistakable water from the emanations of Kilauea. The conclusion, therefore, is not shaken that magmatic waters exist, that they are probably present in deep-seated magmas and, when driven off by solidification, are put into circulation so as to bring ores and gangue from the magmas to form mineral deposits.

Evidence continues to accumulate that the ground waters reach only to comparatively shallow depth, mines and boreholes showing a decreasing water content in the rocks after a certain depth has been passed. The latest estimate on the amount of water found in the rocks, that of M. L. Fuller, gives this water as the equivalent of a sheet only 96 ft. deep over the surface of the earth. The conclusion that water does not descend deep in the earth crust leaves untenable the theory of the formation of deep veins by circulating meteoric waters. Furthermore, the derivation of the ores and gangue by solution along fissures from the sparsely distributed metallic contents of rocks would be slow if not impossible. Percolation through the walls would not seem reasonable when the upper reservoir with all the pull of gravity will not pass downward. In fact, the limitation of the ground waters to the upper zone and to relatively large and open fissures handicaps seriously the processes of leaching and concentration. The alternative agency of vein formation is the magmatic water.

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Norwegian Copper Refinery Closes

The suspension of the Hardanger Iron Works has been noted in the JOURNAL of May 10, 1913. The *Chemical Trade Journal* (Apr. 26, 1913) also announces that the Aktieselskabet Bandak Electrolytiske Kobberverk—formed to refine copper ore at the Aamdal mines by the Hybinette process—has decided to close its works from Apr. 30, owing to an insufficiency of ore in the mine, though the actual refining process is said to have been successful. The local press states that the company intends to reërect the copper-extracting works on the coast near the Christiania Fjord, work to begin during the coming summer. The company owns the Hybinette process for the extraction of copper and zinc from the purple ore from cellulose factories, as well as from natural ores, and it is said this move to the coast points to the intended realization of this project.

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Liquid Air in Metallurgy

The use of liquid air to attain high temperatures in metallurgical work is commented upon favorably in a recent issue of *Echo des Mines.* At Ougrée-Maripaye a Thomas furnace is said to be worked by injecting liquid oxygen, under pressure, into the hearth, where it raises the heat to 2000° C. The reactions take place quickly without any change in the *modus operandi* usual in the making of steel. Large quantities can be treated, as with coal or coke, in a much easier manner than can be done in an electric furnace. The fusion time is reduced one-half, and a furnace can double its output, although there is some trouble in maintaining the furnace walls with such high temperatures.

A Study of Riffles for Hydraulicking

By Pierre Bouery*

SYNOPSIS—Riffles in hydraulic mines usually selected without consideration of ultimate expense. Low grade of La Grange gravel necessitated careful attention to riffle costs. Pine blocks and boulders were discarded for steel rails on wooden riffles and increasingly efficient types of steel riffles were developed. Various devices for utilizing ends of worn rails. High-class material usually cheaper. Results of experiments made to determine saving capacities were checked in practice.

The operation of hydraulic mining consists of washing down the material and of recovering the gold. The devices used for recovering the gold have for their purpose the creation of an obstacle in front of the traveling particles of metal, so that they can stop and settle near the obstacle and be found there afterward. The operation is controlled by the law of gravity, although the early operators in the hydraulic field probably knew nothing of this law. By the law of gravity the materials from the bank are carried by the water into the sluices, and separated during their transportation, so that the heavy ones remain behind, while the lighter ones travel faster and farther. Each piece of material takes its place according to its size and weight.

Riffles are artificial obstacles laid in a sluice for the purpose of lowering the speed of the materials carried in the sluice, classifying them while impeding their course as little as possible, and giving the precious metals or other valuable materials a chance to deposit at the riffle before reaching the end of the sluice. The heavier the metal or material to be saved, the easier is its recovery. The maximum recovery with the minimum loss will be reached when the interval, the shape, the depth, and the nature of the materials used for riffles is such that they are not liable to great changes due to wear, but will maintain their original saving-capacity. This consideration of maximum efficiency has been the object of this special study of riffles, involving their shapes and the different materials of which they may be most economically constructed. I do not claim to have solved the problem completely in every special case, nor to be the first one devoting so much time to the study, but my experience, covering a period of 12 years with the same mine, has resulted in a series of successive eliminations, and the final adoption of a riffle which realized our purpose of saving the maximum amount of gold at the least expense. Fig. 1 represents a general view of our sluiceway and shows the size of some of the boulders handled, which must often be drilled and blasted as here illustrated.

Considerations Governing Choice of Materials

In a hydraulic mine, the choice of materials for riffles depends upon first cost, cost of transportation, cost of maintenance, facility of supply, etc. It is general practice to use the most convenient and handy material without consideration of its real economy. This course is far from wise, especially when low-grade gravels are being handled, necessitating that the riffles always operate at their maximum saving-capacity in order to accommodate the large amount of material which the low grade of the deposit requires shall be treated. Conditions in such a low-grade deposit require that the riffles shall: (1) Oppose a minimum resistance to the movement of the material; (2) resist wear; (3) maintain their saving capacity at its highest point; (4) be sufficient in number to recover all the gold commercially recoverable. The necessity of a minimum resistance to transportation is due to the fact that the water must be made to perform the highest possible duty. A high resistance to wear reduces the work of replacing and maintaining the riffles and also preserves their saving capacity.

It is an important question as to whether the riffles be placed longitudinally or across the sluiceway, both methods having their advantage, according to whether there is wanted a riffle with a short lifetime or one with a long lifetime.

Wooden Blocks Used

In my first experiments, I used riffles of wooden pine blocks 13x13x13 in., or 16x16x13 in., set in rows across

Fig. 1. General View of Sluice, Showing Large Boulders in Process of Drilling

the sluice, each row being separated from its neighbor by a crosspiece of 2x3-in. material 6 ft. long. The arrangement of the blocks is shown in Fig. 2. These blocks were pressed tightly together and nailed to the cross-pieces. They were held down along the edges by 3x4-in. by 12-ft. strips, while higher on the sides of the sluiceway, and resting on the strips, were 3x12x12-in. pine blocks, to protect the sides from wear. Riffles such as these were used in the first 40 boxes of the sluice, each box being 12 ft. long; the lower boxes were paved with boulders, set on a false bottom, as seen in Fig. 3, their object being to overcome the impact of the tailings.

The life of the wooden blocks was from 45 days to three months, according to their place in the sluiceway, those in the higher boxes lasting longer than those below. The boulders lasted longer, but it was difficult to keep them in place. When it was necessary to replace worn material we had to clean up the bottom altogether so that the blocks might rest smoothly on the bottom board. This was not only an inconvenience but an extra ex-

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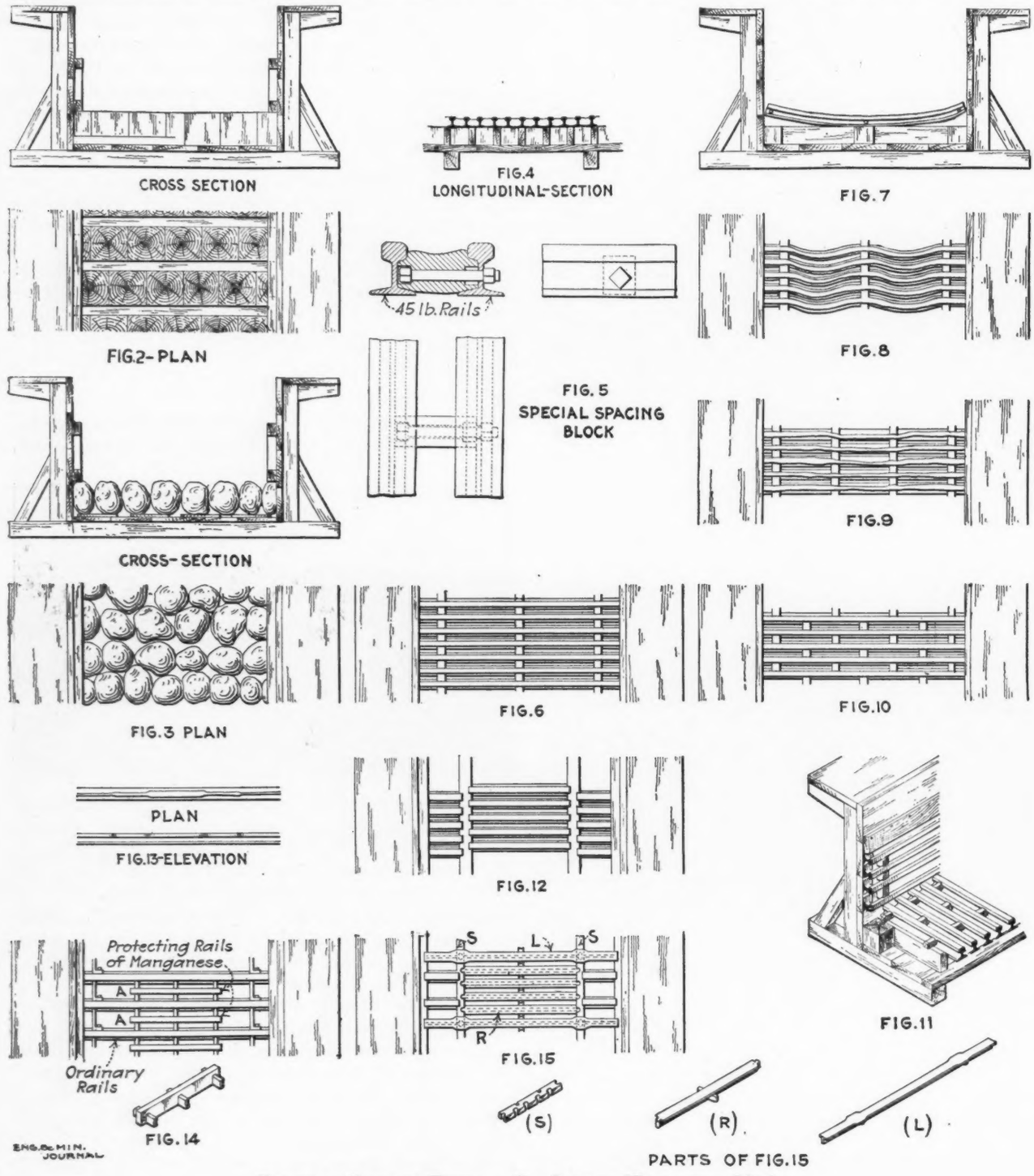
pense. The difficulty became more acute when we attempted to increase the efficiency of our water. This was not easy to do; but by changing the system of piping we obtained an increase in efficiency of 40% or more. However, this increased duty decreased the life of the blocks about 60%, so that in every 17 days of a full run, we had to clean up. This annoyance and expense, together with the fact that our supply of pine blocks was limited by the life of the neighboring forest, led me to request the directors for an appropriation for experimenting with other materials. This was refused and I found myself forced to engage in experiments at my own expense.

Experiments Undertaken with Steel Rails

I began with steel rails, and my previous experience had shown me that probably the best results would be obtained by setting these crosswise in the sluice. I had my choice of 16-, 25-, 45- and 55-lb. rails, but decided that the 16- and 25-lb. were too light, while in the 55-lb., the web and flange were too large in comparison with the head. Consequently I decided on the 45-lb., which I



Types of Riffles Tried at La Grange Hydraulic Mine

have since changed to a 40-lb. rail as being more economical.

The determination of the proper spacing was important and was deduced from a series of experiments which considered the grade of the sluice and the thickness of the layer of running water on the riffle. The relation between the velocity of the water and the material carried can be expressed in the form of a curve, but I omit formulas in this discussion. I conducted some experiments in clear water by throwing in special small rocks, then turning off the stream, finding the rocks and measuring the distance they had traveled. This was not an extremely valuable experiment, but it gave suggestions.

Wooden Riffles under the Rails

Further investigation convinced me that the height of the rails alone could not give sufficient depth for saving the gold and, furthermore, that with the base of the rail directly on the bottom of the sluice, eddies were formed which might wear the bottom and create new troubles. Therefore, I covered the bottom boards with a series of wooden riffles as seen in Fig. 4, made of 2x6-in. pieces six feet long, with blocks nailed to them to provide spaces for gathering the gold, and on these the rail riffles were set, thus acting really only as a protection to the wooden riffles below. I fitted out two boxes in this fashion and set them in place of boxes 20 and 21, in order to have

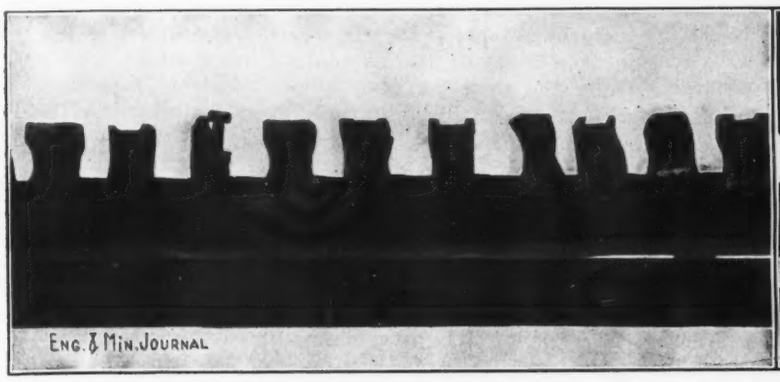


Fig. 16. 40-Lb. Steel Rails Set Lengthwise and Spaced Five Inches; after Handling 400,000 Miners' Inches of Water

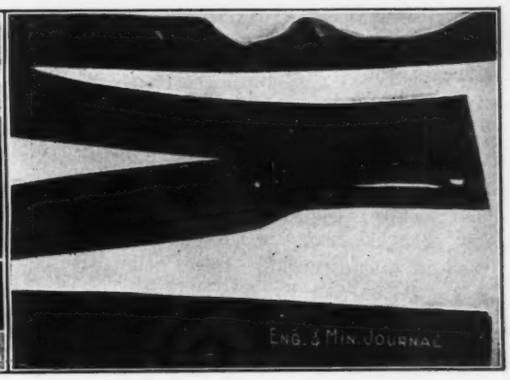


Fig. 17. 40-Lb. Steel Rails Set Crosswise after Handling 600,000 Miners' Inches

Fig. 19. Setting Steel Riffles

Fig. 20. Riffles of Fig. 19 after Wear

A particle of material carried along by the water may fall between two riffles or it may strike one riffle and bound off. In either case the final result will be for the particle to come to rest between two riffles and remain there until dislodged by a stronger force. The grade in the sluices was seven or eight inches to the box of 12 ft. and the depth of water varied from 12 to 18 in. A spacing of five inches between the center of the rails was decided upon as the best interval. For other grades and other depths different spacing intervals would probably be more advantageous, but I question whether it would pay to go below four inches or above six, as the first case would increase the expense and the second might create obstacles between the rails, which would interfere with dumping the tailings.

them removed from the blockades at the head of the sluice. Boxes 1 to 19 inclusive had the original wood riffles and boxes 22 to the end were paved with boulders.

At the end of three months, when the blocks were worn out, boxes 19, 20 and 21 were cleaned separately and their contents kept apart. In ordinary circumstances, box 19 would have contained more gold than box 20, but, as a matter of fact, there was in box 20, 2½ times as much gold as in box 19, and in box 21, a little less than twice as much as in box 19. These conclusive results induced the directors to allow me to install new riffles instead of the old type.

While the results obtained with the rails were better than with the pine blocks and boulders, they were not altogether satisfactory. For one thing, there was a great

increase in the duty of the water and a consequent greater increase in the wear on the riffles. But the result of the year's run on the new system showed that the gravel never packed hard between the rails and also that gold, whether free or amalgamated, was never found between the rails.

Cast-Iron Spacers in Different Combinations

In the use of rails, it is necessary that they be kept independent and at the same time solid. To obtain this result, a special filling-block shown in Fig. 5 was designed and made of cast iron. The shape of this block, conforming to the shape of the rails, made a solid system in the sluiceway, and prevented the rails from upsetting. This last is an important point, as, if for any reason the surface of the riffles becomes unequal in the sluiceway, obstacles are created and the discharge of material is impeded. The original disposition of the spacing blocks is shown in Fig. 6, three blocks being used for each 6-ft. length of rail. The wear is much greater in the center of a sluiceway than on the side, and as a result, after a few months' run, the rails placed in this way become curved in one direction or the other, as seen in Figs. 7 and 8. To correct this, four blocks were used as shown in Fig. 9, with the result that bending was eliminated, but in the center of the sluiceway, in the channel formed by the two middle blocks, the attrition was severe, so that the rails wore and broke at this place while still good on the end. The final arrangement is that shown in Fig. 10, using seven spacing blocks for each pair of rails. In this manner it was found that when discarded, the rails were $\frac{5}{8}$ worn out instead of $\frac{3}{8}$ as formerly. During these experiments, the shapes of the blocks were also changed to arrive at the point of highest economy.

Sides of Sluice Protected with Scrap Rail

The ends of the worn rails were utilized to protect the sides of the sluice box from wear. Their arrangement for this purpose is that shown in Fig. 11. The rail ends were bolted together in sets of four by long bolts at the ends, with special spacing blocks to keep the heads apart. They were held against the side of the box by nails bent over the flange of the top rail and by a 2x6-in. board, also set on the top flange. This arrangement did not so much increase the duty of the water as it decreased the expense due to replacing the wooden blocks formerly used for this purpose. These side rails usually lasted from five to seven years and handled about 30,000,000 cu.yd. of gravel.

High-Class Material Is Usually Cheaper

The cost of riffle material can be considered as made up of first cost at the manufacturing plant and transportation cost. Where transportation is high, it pays to use a high-class material. There is, however, a limit, at which a low cost-price plus the high cost of repeated transportations is equal to a high cost-price plus the low cost of a single transportation. How high a price for material is it worth while to pay in such circumstances? Consider two sluices working under similar conditions, that is, for the same length of time, with the same quantity of water and handling the same amount of material. Suppose that in the first sluice the riffle material is renewed every year, while in the second sluice the material will last N years. Let the cost at the manufacturing plant of the riffle material for the first sluice be A, and the transportation cost be B. In N years' run the cost of riffles for the first sluice will be $N \times A + N \times B$. Let X equal the cost at the manufacturing plant of the material for the second sluice; then in N years' run the cost of the second sluice is $X + B$. Supposing these costs to be equal, then $N \times A + N \times B = X + B$; or $X = N \times A + (N - 1)\ B$. When X is equal to the second term, there is no economy in buying material at that price, but if X is smaller, the economy increases approximately as N, the number of years, increases.

In addition to the direct saving due to using high-class material, there is the saving in labor and interruption to operations, due to replacing worn riffles. The cost of these operations decreases as the frequency of replacements decreases. In order to find out what material was really the most economical, we considered experiments with titanium steel, chrome steel, cast steel, nickel steel and manganese steel. Nickel and chrome steels we could not obtain, but we experimented with the other steels and, as a result, selected manganese steel as being preferable to the others.

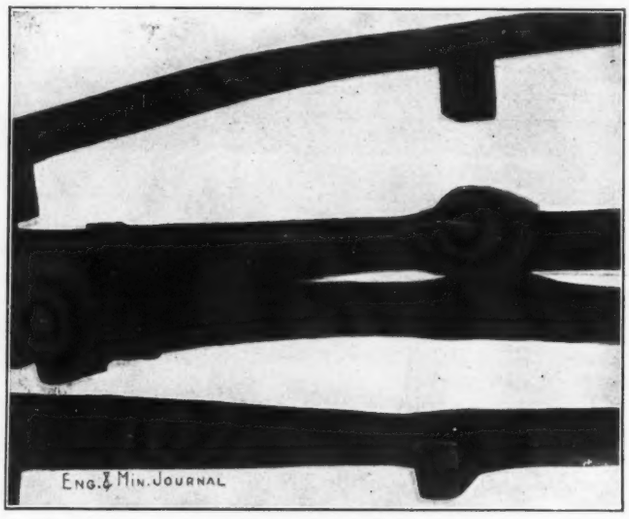


Fig. 18. Portions of Special Manganese-Steel Rails

Attempts to Utilize Scrap Rail

In spite of using the ends of the rails for lining the sluice sides, we found that the scrap pile was growing far too large. Consequently we tried setting the scrap rails with the flanges uppermost in the sluice. The rails, however, had become brittle; apparently a molecular change had taken place and crystallization resulted, so that they were quite unavailable. Lacking means to anneal them, we built a primitive furnace, heated them to a cherry red and found we obtained a rail satisfactory, so far as brittleness was concerned, but subject to rapid wear on account of having lost its temper. The idea occurred to our foreman of bolting five rails together and putting them flange up in the sluiceway, but between each flange, putting two pieces of broken rail projecting above the flanges. This gave a satisfactory result and aided materially in reducing the scrap pile.

Method of Using Short Rail Sections

Another expedient is that illustrated in Fig. 12, which consists of putting higher-class riffles in the middle sec-

tion, where the maximum wear takes place. In this arrangement the length of a middle section is about equal to the length of the two side-sections and this middle section consists of new rails, while the outside sections are built of the ends of worn rails. The rails are held in notches made in the two spacers at the regular 5-in. intervals, and these spacers are firmly fixed by 6-ft. rails which stretch across the entire sluice. Such an arrangement constitutes a set six feet long, which is laid upon the wooden riffles and kept solid by the side linings. Fig. 19 illustrates the manner of setting the short rails in the sluice and Fig. 20 shows the same box after having been somewhat worn. For the middle rails, we tried various steels with the following results: Rails made of

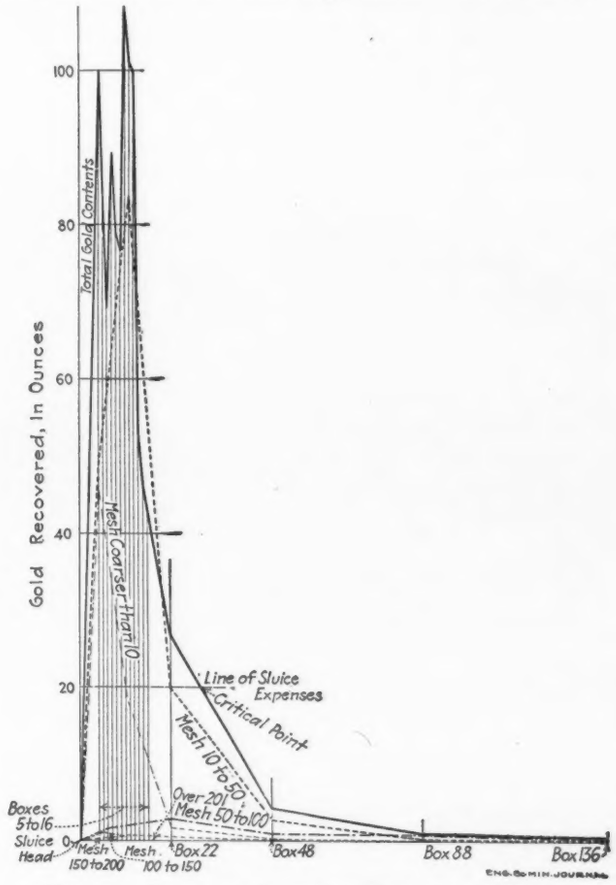


FIG. 21. DIAGRAM SHOWING RECOVERY OF GOLD IN SLUICES

cast steel, being porous, did not resist the wear for any great length of time, but broke in some cases after 12 days' run; titanium steel could not be obtained except cast, which was too brittle, although it resisted wear well; manganese steel proved the most satisfactory.

In experimenting with the manganese we attempted to save metal by decreasing the thickness of the head as shown in Fig. 13, thus keeping the bulk of the material where the bulk of the wear took place; but, such a rail did not resist wear for a long enough time and the idea was abandoned. However, another new shape gave excellent results and this shape, made of manganese steel, was finally adopted.

CROSSWISE RIFFLES SUPERIOR

The advantage has always been with rails set across the sluice. The explanation of this is rather simple, since with a rail set lengthwise, a particle of sand striking on the head, the web or the flange may continue in contact for the entire course of the rail, eroding its surface for that distance, whereas, if set crosswise, the grinding action is limited to the top. Fig. 16 represents a box of 18-ft. rails, set lengthwise and spaced five inches, which were worn out after handling 400,000 miner's inches of water, the term miner's inch being used thus to designate the volume of water which a flow of one miner's inch will furnish in 24 hr. or about 80 cu.yd. It should be noted that the 18-ft. rails set longitudinally wore faster when spaced eight inches than when spaced five inches. Fig. 17 shows some 6-ft. rails, set crosswise of the sluice, and spaced five inches, which were discarded after handling 600,000 miner's inches. Fig. 18 is the best manganese-steel riffle yet used. It handled 2,200,000 miner's inches of water and from 12,000,000 to 15,000,000 cu.yd. of gravel.

As the rails are brought closer and closer together and the space between them decreased, they finally give a smooth surface, with no capacity for saving gold, but with a maximum of transporting power. This is of no advantage except at the head and end of the sluiceway where it is not expected to save gold, but where it is important to obtain a high velocity in order to avoid blocking.

OTHER MORE ELABORATE SYSTEMS OF RIFFLES

One arrangement with which experiments were made, is shown in Fig. 14. It consists of ordinary rails with half-length manganese-steel rails set between them at 6-in. intervals. It is a good riffle, but does not show enough advantage to compensate for the increased labor of putting it together. In Fig. 15 is exhibited a new riffle, which, in my opinion, contains all the qualities necessary for the work demanded. that is, high gold-saving capacity, slow wear, easy setting, rigidity and security against theft. The set consists of three different pieces, the riffle proper, the spacer and the locker. In putting it together, the ends of each riffle are clamped down by notches in the spacers, which, in turn, are clamped by the lockers. The outside notches of the spacers carry the short rails. The side-lining rails, in turn, hold down the locker and no piece can be removed until the side lining has been removed. Patent has been applied for on this riffle. It is evident, in a sluice 3600 ft. long, covered, bottom and sides, with rails and handling millions of cubic yards of gravel a year, that it is essential to select riffles which combine to the highest possible degree the necessary qualities.

EXPERIMENTS MADE ON SAVING CAPACITIES

Some data on the saving capacity of riffles, the results of experiments made in the winter of 1910, may be of interest. These experiments were carried out during a period of 15 days and were stopped because a full head of water came on, not because sufficient data were collected. In the experiments we cleaned up separately as many sluice boxes as possible, weighed the amalgam of each box, retorted the quicksilver, weighed the gold remaining, and made a screen analysis of this gold. Since it was too long a process to retort separately the amalgam for each box, we grouped these to a certain extent and the recovered gold has been distributed to the boxes in the group according to the percentage of amalgam. This distribution is shown in Table I. The value of the

amalgam was found to vary from $13.50 per oz. at the head boxes, to $6 in box 136. The screen analysis of the boxes is shown in Table II. The value of this experiment

TABLE I. RESULTS OF EXPERIMENTS TO DETERMINE THE RELATIVE TOTAL RECOVERY OF GOLD IN BOXES AT DIFFERENT POINTS IN A SLUICEWAY

Box number	Ounces	Box number	Ounces	Box number	Ounces
5	100	10	75	15	46
6	80	11	108	16	43
7	69	12	101	22	26.2
8	88	13	100	48	4.15
9	68	14	53	88	0.65
				136	0.14

lies in showing that at a certain point not enough gold is collected to pay for the maintenance of a box and in this way the work can be better directed. However, it is not always practicable to cut off a sluiceway at the point at which economic saving ceases.

TABLE II. DISTRIBUTION OF THE GOLD IN THE DIFFERENT BOXES ACCORDING TO FINENESS

Box number	Lying on 10 mesh	10–50 mesh	50–100 mesh	100–150 mesh	200–150 mesh	Passing 200 mesh
5	45.80 oz.	50.70 oz.	1.38 oz.	0.36	0.31	1.45
6–16 incl.	18.00	83.30	2.33	1.00	0.31	0.83
22	1.73	20.22	3.08	0.70	0.25	0.62
48	0.18	2.18	1.06	0.12	0.05	0.16
88	0.018	0.12	0.47	0.008	0.026	0.005
136	none	0.053	0.027	0.043	0.011	0.01

The results shown in the tables have been plotted in Fig. 21 in which the abscissas represent the numbers of the boxes and the ordinates, the amount of gold recovered. The fact that the boxes at the head of the sluice do not show the highest saving is explained by the fact that these boxes are often blocked with boulders and sand. The point where the line marked "sluice expense," representing the cost of maintaining the boxes, cuts the curve representing the total saving of gold, represents the point at which the sluice no longer pays for its maintenance. However, in this case there were other reasons for maintaining the length of the sluice.

It was found that the undercurrents were a source of trouble, as they packed too easily and there was no gold recovered in them, all the fine gold resting between the riffles. They were therefore suppressed.

Data from Experiments Checked in Practice

The accuracy of these experiments was checked by calculating in advance the probable saving of gold in a given period of time. Thus in April, 1910, the gold-saving calculated in advance was correct by less than one part in 1000 and in the following year by a little over two parts in 1000. The help thus afforded in directing the work is evident. The adoption of this efficient riffle system has worked to the detriment of the "gold mossing" miners. It has been the custom for miners of the vicinity to gather the moss which grows on rocks in the river beds during low water periods and collects gold during high-water periods. By collecting and burning this moss, men have been able to clean up from $15 to $20 per day for a period of two weeks, but the industry no longer pays, an eloquent testimonial to the efficiency of the new type of riffles.

Compressed Air Locomotive Tests

For the construction of the Mont d'Or tunnel, the A. Borsig works, Berlin-Tegel, Germany, delivered two locomotives of different types; one a three-axle of 11 tons weight and the other a four-axle of 31 tons, both with compound air cylinders and double preheating of the air (*Glückauf;* abstr. *Comp. Air Mag.,* April, 1913).

The air is carried at high pressure in two long cylindrical tanks, and after coming from the pressure-reducing valve it passes through a special set of heater pipes before entering the high-pressure cylinder and doing that portion of its work. In passing from the high-pressure to the low-pressure cylinder it is led through a second set of similar heating pipes. The furnace for heating the pipes is on the locomotive frame, a small stack being provided in the front part of the locomotive to take care of the gases of combustion. Coal and charcoal are used for fuel in order to obtain a practically smokeless combustion. The preheating is such as to raise the temperature of the air in both cylinders to about 180° C. With a grade of 0.13%, the larger locomotives can haul up to 180, and the smaller up to 55 metric tons gross.

Some tests made on the locomotives are interesting, as the pressure of work in conducting tunneling operations is usually such as to preclude making tests. Some of the results are shown in the accompanying table. During the tests the locomotive was in front of the train when it moved in and behind when it moved out of the tunnel. In normal operation the opposite arrangement is, of course, used, since on a grade of 0.13% with the heavy train, a break of a coupling would cause great danger unless the locomotive was always below grade from the train. To take care of that during the tests, there was always a second locomotive at some distance on the other side of the train. Both locomotives were tested just as they were, without previous overhauling or even cleaning. Previous to the tests they had been over a year in actual service on the construction. The air capacity of the tanks could be established only by calculation, and was found to be for the small locomotive 78.75 cu.ft., and for the large locomotive 357 cu.ft. The comparatively low temperature of preheating indicates that the smokestack was choked up, the temperatures obtained at the delivery tests having been considerably higher. It is stated, however, that temperatures of 45 to 54° C. in front of the low-pressure cylinder are about as high as one can go economically with this kind of locomotive where strong preheating permits the expansion of the air to be driven extremely high in the cylinder.

RESULTS OF TESTS ON GERMAN COMPRESSED-AIR LOCOMOTIVES

		Initial pressure of air in tanks, atmospheres	Final pressure of air in tanks, atmospheres	Temperature of entering air at beginning: High-press. cylinder	Temperature of entering air at beginning: Low-press. cylinder	Temperature of entering air at end: High-press. cylinder	Temperature of entering air at end: Low-press. cylinder	Run miles	Gross load short tons	Useful load short tons	Output ton-miles	Tractive effort lb.	Air consumption: Total, cu.ft.	Air consumption: Cu.ft. per ton-mile
Small Locomotive	Upgrade	84	29					0.621	69.4	50.7	43.1	3579	4,332	32.0
	Downgrade					80° C	45° C	0.621	69.4	50.7	43.1	132	188	1.22
Large Locomotive	Upgrade	68	23	80° C	80° C			1.16	166.3	125.8	192.9	8019	16,065	26.3
	Downgrade					64° C	58° C	1.09	166.3	114.2	181.3	220	455	0.79

It was stated, however, that temperatures of 45 to 54° C. in front of the low-pressure cylinder are about as high as one can go economically with this kind of locomotive where strong preheating permits the expansion of the air to be driven extremely high in the cylinder.

The Union Copper Land & Mining Co., of Boston, reports that during the last year considerable interest has been shown in the company's land both for mineral and timber values. Options have been granted on several different descriptions and the Board of Directors have other bids under consideration. The general value of the whole property is said to be greater than it was a year ago, due to the discovery of valuable deposits of copper on contiguous land. The company finished the year with $3853 cash in the bank and with total land holdings unchanged at 6366.7 acres.

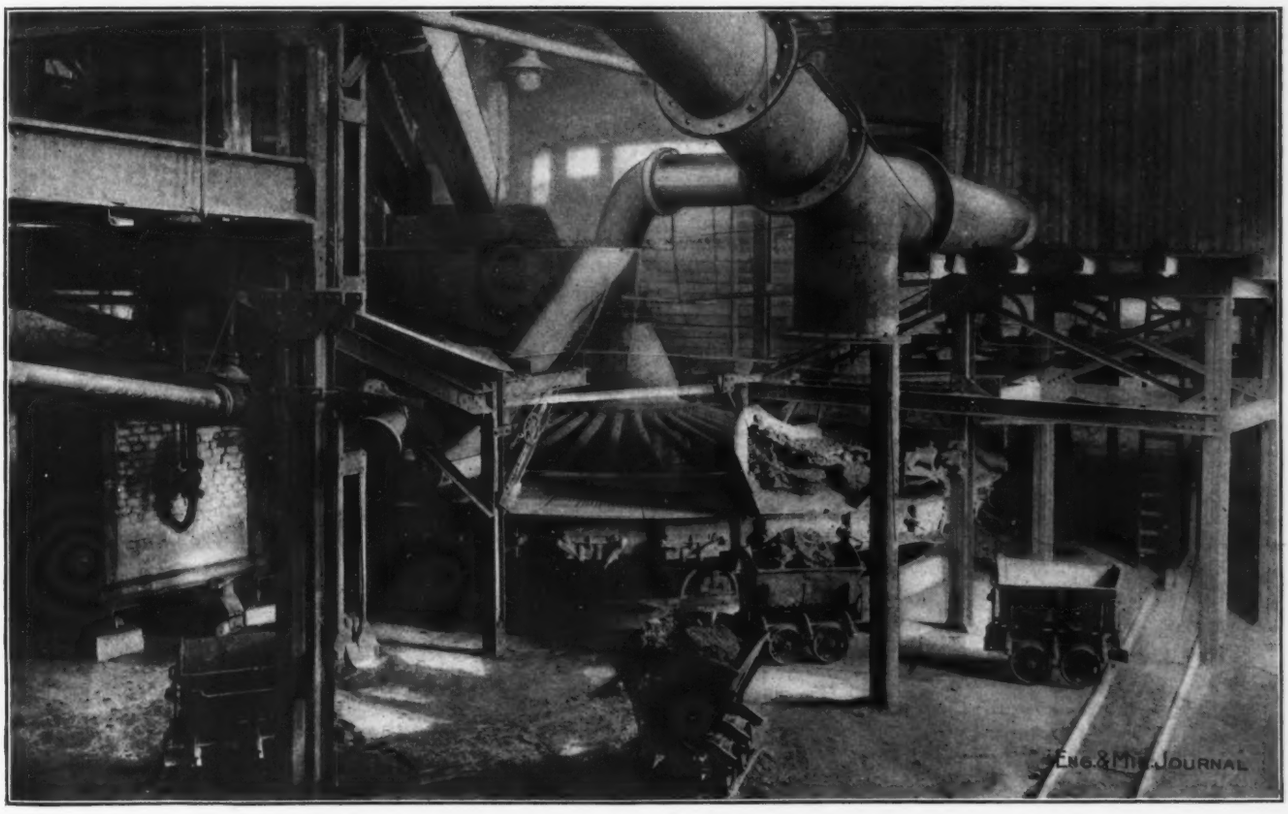
CORRESPONDENCE AND DISCUSSION

A German Dwight-Lloyd Installation

[We received a clipping from the London *Mining Journal* referring to an article which appeared in the *Mitteilungen des Institute für Gewerbe Hygiene* about the Dwight & Lloyd installation at the Binsfieldhammer Lead Works, near Stolberg, Germany, and asked Mr. Dwight about it. He replied as follows.—EDITOR.]

I have no detailed information about this particular installation, but I know there are a number of Dwight & Lloyd plants in operation in various parts of Europe, and one or two near Stolberg. The article quoted has evidently been translated by someone who is not perfectly conversant with the facts, as some of the terms are used incorrectly, but I judge that the so-called "modification" of the Dwight & Lloyd apparatus refers to a type of the machine designed by Felix Von Schlippenbach of the Rhein-Nassau plant. This is a round-table machine, i.e., a horizontal annular or ring-shape machine, and is practically similar to some of these shown in our American patents. Our European friends prefer to use this style of mechanism to the straight-line conveyor type, which we have adopted as a standard in this country. I believe that we are doing better here with the latter type. However, they seem to be satisfied also.

When Dr. Ferdinand Heberlein was in this country last fall, he stated publicly at a session of the Congress of Applied Chemistry, while discussing a paper presented by me, that the great advantage offered by the Dwight & Lloyd process compared with the H. & H. pots was the freedom from lead sickness among the workmen, who had unquestionably suffered considerably in breaking up the large cakes of the H. & H. material. He stated further that the German government was taking special notice of this fact and was strongly recommending the installation of the Dwight & Lloyd apparatus in all plants where much lead poisoning was found to result from the use of the pots.



GERMAN DWIGHT-LLOYD SINTERING PLANT

In the JOURNAL of Jan. 20, 1912, there was an article by Max Hasenclaver on sulphuric acid, in which he stated that the Dwight & Lloyd machines were being used in a number of plants for roasting galena ores where the gases were utilized in the manufacture of sulphuric acid. He inferred that this practice was becoming general. In this connection it is interesting to note that by selecting gases from a certain part of the cycle, a gas much richer in SO_2 is obtained, while a small amount of gas poor in SO_2 is rejected.

A. S. DWIGHT.

New York, Mar. 24, 1913.

Consulting Engineers

George E. Collins in an article entitled "Searching for Oreshoots in Veins," reprinted in the JOURNAL of May 10, remarks on the slight value of the outside expert called into consultation on a property. "The man who has the best opportunity to study the deposit," he says, "is he who is familiar with it throughout the entire period when it is being worked; who sees the freshly broken face of each drift, and the developments from day to day in every working place. A relatively less degree of ability so applied may be expected to yield greater results than an occasional visit from an eminent scientific authority." The article contains other statements to similar effect and is a vindication of "the man on the job."

Extending this sentiment to cover engineers as well as geologists, it becomes one calculated to win heartfelt and enthusiastic applause from all that numerous band of hard-working, able superintendents and managers, who keep our mines going in spite of the consulting engineers who hinder their efforts and pester their lives. I use the word "pester" advisedly; the average consulting engineer today *is* a pest. This is no disparagement of the real leaders of the profession, those honestly graduated into the consulting class, who are largely responsible for the advances that mining science makes; the number of these men is most limited, however, and the bulk of the so called consulting tribe is made up of half-baked experimenters, operative failures, shysters and downright crooks.

To be a consulting engineer requires a glib tongue, a superficial knowledge of several districts, a highly developed critical faculty, and a diabolical ingenuity in escaping consequences. Of constructive ability he has no need. Engineering is a matter of detail; the success or failure of a method or an enterprise will hinge entirely on details and particularly on the details of the conditions under which it is attempted to apply it. Of these, the consulting engineer takes no heed. He blithely prescribes for one mine a method he has seen in successful operation at another, disposes matters so that he can take the credit for the occasional success and escape the blame for the usual failure, and merrily draws down his pay. He builds his reputation on bluff and the work of other abler men. He is a positive parasite on the mining industry, not only a financial drain because of the salary or fees he receives, but also by his operations tending to diminish the efficiency of the superintendent whom he directs, thus increasing the cost of all metal-winning processes. Happy the mine that has no consulting engineer!

CARL E. MORRIS.

New York, May 12, 1913.

American Tin Dredges

In the JOURNAL of Apr. 26, 1913, p. 866, we note the following in reference to tin dredging: "American dredge builders have not yet participated in the tin-dredging business."

We built a dredge for placer tin as far back as 1911, and are still operating it. At the present time we are constructing a 4-ft. dredge for placer-tin operations in Portugal. This dredge has 4-cu.ft. buckets and an all-steel hull, and is under the personal supervision of H. G. Peake.

In view of these facts we trust you will give a little space to the correction of the error published.

UNION CONSTRUCTION CO.,
By R. H. BLACK.

San Francisco, May 5, 1913.

Principles of the Diesel Engine

There were several errors in my article on the Diesel engine, in the JOURNAL of Apr. 26, 1913. On p. 843, the reference at the bottom of the right-hand column should read, "while Fig. 5 shows heat balance of different heat engines under test conditions;" not, "Fig. 2," which is the performance curve of a Sulzer 300-hp., 4-cycle, single-acting engine. On p. 846, the bottom of the left-hand column should read, "and above 1500 b.hp. per unit;" not, "150 b.hp. On p. 848 the top of the right-hand column should read, "will give the large installation, from 5000 kw. upwards the economic preference;" not, "from 500 kw. upwards."

The last error I particularly regret, because it cannot fail to give entirely wrong impressions about the economic value of the Diesel engine as a prime mover for large central stations.

I know of one recent installation of two 2500-kw. Diesel-engine-driven generators, that, compared with a complete steam plant, with two 2500-kw. turbo-generators, showed a yearly saving of $25,000, notwithstanding the fact that expensive coal-tar oil was used as fuel, and that the Diesel-engine installation was more expensive. The area occupied by the Diesel-engine plant was less than 54% of that required by the complete steam plant.

In the matters of waste, there is hardly a greater service that the JOURNAL could do, than that of unceasingly and untiringly calling attention to the reckless economic wastes still going on in America. I have in mind in particular the barbaric practice of coking in bee-hive ovens without even utilizing the gases under boilers, which practice furnishes us still with the bulk of the coke, not mentioning even the great coal losses so prevalent in our coal-mining practice.

In matters of conservation, powerful and well financed organizations like the U. S. Steel Corporation, that adopt more modern and economic methods, can and should be regarded as a boon to the country, although the tendency of capitalizing earnings, and overcapitalizations in general, should be stopped.

These wastes should be brought home by graphic methods. Figures do not tell the story so well as graphic pictures. The kind of patriotism that conveys to the public an idea of what others save, and what we waste, is as much a civic duty as endeavors in other directions.

I am not the kind of conversation-faddist, that wants to utilize all the millions of tons of sulphur our smelteries send into the atmosphere, although I hold that the nuisance should be stopped or alleviated as much as possible. The saving of wastes should begin in those industries that waste, because they do not make use of the most approved methods, and this applies to a great extent to our coal industry.

H. HAAS.

San Francisco, Calif., May 8, 1913.

EDITORIALS

The Situation in Spelter

The decline in the value of spelter from about 7¼c. only about six months ago to about 5¼c. now, and the corresponding decline in the value of zinc ore, is a matter of discouragement and disappointment in the zinc business, especially among the producers of ore. Yet as is generally the case in such experiences, eyes are kept shut to the real reasons that caused them to happen.

In the present case the prospective reduction in the tariff on spelter and zinc ore has obviously had nothing to do with the events. On the contrary the possession of a high tariff played a part in bringing about the cataclysm. At present American smelters, according to market quotations, ought to be about at the point of exporting spelter to Europe. There is reason to suspect, however, that stocks are accumulating over there, that the convention may be disposed to sell at less than the open quotations, and that the offering of American spelter would aggravate the situation without accomplishing anything good for anybody.

As to the situation here, it has at last become clear that consumers were needlessly scared in 1912 by fears of an immediate exhaustion of the supply of natural gas in Kansas and Oklahoma and the consequent crippling of the smelters in those states. Anyway, they were led to take in huge supplies of the metal at steadily advancing prices; so eager were they to buy that the smelters were not permitted to accumulate any stock and for long periods were called upon to ship their output hot from their furnaces. Of course, speculators put their sticks in the pot and stirred to make things boil further. Finally the price was boosted to a point where it became possible to import European spelter, paying the duty, and upward of 10,000 tons were brought in. Soon afterward the consumers began to reduce their purchases. They had been gorged to repletion. The smelters immediately became uneasy, as they always do in this highly competitive business when they are unable to sell steadily, and cutting of prices promptly began.

The statistics that we published last week showed that the deliveries of spelter by the smelters in 1911 increased by 44,500 tons over 1910, or 16%; and in 1912 increased by 45,000 tons more, or 14%. Of course, no one can reasonably suppose that domestic consumption increased to any such extent. It is obvious that while a largely increased production was being absorbed and smelters' stocks were moreover being reduced to a mere nothing, the consumers had been overbuying and must have accumulated a huge stock in their yards. When they came to their senses they ceased buying and the bottom dropped out of the market. It is also obvious now that the importation of spelter from Europe was not only unnecessary, but aggravated the situation that was shortly to ensue. It would have been far better if the advance in price had been checked before these importations became possible.

We shall not say that the producers brought the cataclysm on themselves. We are disposed to think rather that they did not know what was going on, or if they had any suspicions their ideas fell far short of the truth. We shall, however, bring to their attention that they have no ground for complaint respecting the present situation. They succeeded in selling upward of 360,000 tons of spelter in 1912 at nearly 7c. per lb., cleaning out their stock and loading up their customers. So they made a pile of money. Dissatisfaction with the present price for spelter, which after all is approximately what may reasonably be expected as an average, is analogous to the desire to eat one's cake and have it too. If there is any party that now has good grounds for complaint, we think it is the consumers who paid the high prices in 1912.

❧

Changing Mining Methods at Bisbee

The camp of Bisbee has long been noted for the extremely expensive methods necessary to extract the ore in spite of the large size of the mines. The causes of this lie in the irregular nature of the deposits and in the treacherous ground, and the square-set and filling methods adopted are no reflection upon the management of the companies. Nevertheless, it is now being discovered that some of the deposits at least are susceptible to extraction by more economical methods. We are informed that the Copper Queen is now producing nearly 20% of its ore from certain stopes in hard ground where the ore is being cut out without timbers, the extraction being followed by filling, upon which fresh ore is broken.

A similar method is also used by the Calumet & Arizona in sulphide stopes near the Junction shaft. The Mitchell vertical-slice method used by the same company by which a large part of the timber is dispensed with, has been previously described in the JOURNAL. The Copper Queen has recently developed a few orebodies that indicate by their size and regularity of occurrence that they may be successfully sliced. Preparations to that end are now being made, and it is expected that slicing on a large scale will be begun in the early fall. This development is in line with the tendency of all the large copper companies to dispense with the use of timber as far as possible. The complete abandonment of square-setting is not to be expected in Bisbee, at least not in the near future; but a steadily decreasing timber consumption per ton for that camp is probably a safe prophecy.

❧

Crushing Efficiency

The now well known paper of H. Stadler, referring to the relative efficiencies of grinding machines and the attempt to represent them by easily comparable numbers, has opened up a large amount of interesting discussion. Most of the well known authorities have taken part in the argument and the laws of Rittinger and Kick have been advocated as more or less applicable to the problem. In this issue of the JOURNAL appears an article by A. O.

Gates, advocating the applicability of Rittinger's law, and an abstract is published of a paper in which J. W. Bell derives a series of conclusions following Stadler's system, which is based on Kick's law. There seems to have been no decision rendered by the majority of operators in favor either of one system or the other and this discussion will probably lead to further study of the subject, to the benefit of the industry in general. It is to be hoped that the matter will not be dropped until the basic facts and the best means of using them are demonstrated.

❋

The President of the Steel Corporation

The appearance of James A. Farrell, president of the Steel Corporation, as a witness last week in the Government's dissolution suit, revealed him as a great man, whose size has not heretofore been generally recognized as it will be hereafter. Testifying during four days, Mr. Farrell covered the whole field of the company's operations—mining, metallurgical, transportation, selling and everything, and not once did he find it necessary to consult notes, although he recited a multiplicity of figures. No matter whether the subject was the intricacies of the tin market in Singapore, the cost of mining on the Mesabi range, labor conditions in Tennessee or the cost of building the biggest bridge in the world, all was at Mr. Farrell's tongue's end. His command of the details of the great business under his direction was nothing short of marvelous and the disclosure was impressive. The world can see now that the Steel Corporation has at its head no mere steelmaker, but a man of broad education, powerful intellect and commanding personality.

❋

The Steel-Rail Pool

In the testimony given in the Steel Corporation suit by W. E. Corey, formerly, and James A. Farrell, now president, there has appeared to be a direct contradiction, which has excited a good deal of comment. This related to the supposed agreement with foreign rail manufacturers, the existence of which was affirmed by Mr. Corey and positively denied by Mr. Farrell. It seems quite probable that this can be explained in a way.

The rail convention, which was a more or less definite agreement of the English, German, French and Belgian makers, related not so much to prices as to competition for foreign orders. In effect, it was a division of export orders, or rather a limitation of the territory in which each nation might compete for business. Its existence was generally recognized abroad and was freely commented on by the trade papers from various points of view. In this country, however, the steel men—though usually alert enough—were apparently entirely ignorant of its existence. In Europe, especially in Germany, it was generally assumed and believed that the combine had at least some understanding with American makers. In some quarters the existence of a positive agreement was asserted, though that was hardly admitted by others.

Doubtless Mr. Corey knew of these rumors at the time when he was president, and doubtless he knew also that the Steel Corporation and the other American railmakers would not or could not be parties to any formal agreement of the kind. If there was any understanding between European and American makers, it was probably of rather shadowy and tenuous kind or very carefully guarded. Mr. Farrell seems to have been quite justified in his denial of American participation.

International agreements of this kind are more easily made than kept, and it does not appear that European mills adhered strictly to their covenants except for a short time. From his point of view, Mr. Farrell was quite justified in his denial of the existence of a rail pool of any formal or definite sort in which the Steel Corporation had part.

❋

Scientific Methods Applied to Hydraulic Mining

La Grange mine has long been famous for the great scale of its operations and for the extremely low grade of its gravels, which nevertheless yield a handsome profit. Some of the labor, intelligence and pertinacity necessary to bring this profit into being are evident after reading the account of the riffle experiments presented by Mr. Bouery in this issue of the JOURNAL. His extraordinary success as manager of the property is a tribute both to personal ability, and to the scientific methods which he applied. It is remarkable that a stranger to the country and to hydraulic mining should have been able to take charge of a property in an unsatisfactory condition, and by dint of an extensive study of the basic laws, followed by a series of patient experiments, teach not only himself but also the native scoffers to whom hydraulic mining knowledge should come as a birthright.

That is, we believe, Mr. Bouery's first contribution to mining literature, and it is for that reason doubly welcome. Articles such as this, are as difficult to come by, as they are valuable to the profession. It is rare that one who really knows, can be persuaded to publish his knowledge. Such an event has taken place, however, in this case and the result is what may fairly be described as the last word on hydraulic riffles.

❋

The U. S. Geological Survey has had another fire, this time experiencing a loss estimated at $100,000. This fire, which occurred on May 18, was the fifth fire in the building in six years and was the most serious. Congress has authorized a new building for the Survey, but has not made any appropriation for it. The entire responsibility for the almost criminal neglect in this matter is definitely fixed upon Congress. According to the law of probabilities a sixth fire should occur in a little more than one year from this date. That may perhaps burn all the records of the Survey, after which Congress may express its sorrow and prepare to supply a new building.

❋

In the JOURNAL of this week begins a series of articles on modern American copper-smelting practice, by Richard H. Vail, assistant editor of the JOURNAL, himself an experienced copper smelter. His first article describes one of the smelteries in the neighborhood of New York, a plant where there is some peculiar and interesting metallurgical practice. Mr. Vail is now in Arizona, visiting the works of that state, after which he will go to all of the important copper-smelting plants of the country. This series of articles will undoubtedly be of great interest and value to our metallurgical readers.

BY THE WAY

Where lithia is used has been a mystery to most of us, but it is now explained that lithium hydrate is added to the hydroxide storage batteries (Edison type), as a stabilizer. As carbon dioxide is absorbed by the electrolyte it precipitates as lithium carbonate, leaving the more active alkali unaffected.

❖

We may soon have some judicial pronouncement respecting how mines should be valued, four Michigan subsidiaries of the Steel Corporation having brought suit to have their taxes reduced, claiming that the valuation of J. R. Finlay was made by incorrect methods. Hearings began at Bessemer, Mich., on Apr. 25.

❖

Radium now has its own special journal, a paper of the same name, published in Pittsburgh, Penn. The first number, April, 1913, has a history of radium investigations; a long paper on uranium in Colorado; a translation of a German article on radiotherapy applied to rheumatism and gout; and some general notes and comment.

❖

One effect of the recent strike at Ely, Nev., was to eliminate the Greeks as the controlling element in the common labor of the district. While there are still many Greeks employed, it is said they are no longer in an overwhelming majority, and the labor situation is much improved by the change. About 200 Japanese are employed as laborers around the steam-shovel pits at Copper Flat, and a great many are also employed around the Steptoe smelting plant. They have so far given excellent satisfaction.

❖

James A. Farrell, president of the U. S. Steel Corporation, who is now 50 years old, in describing his rise to his present position, said that he entered the steel business at the age of 15 years as a laborer in a steel mill in New Haven, Conn. At 19 he went to Pittsburgh and worked as a "wiredrawer." At 21 he became foreman of the mill, and at 23 a salesman. From this position he was promoted to be sales manager at the age of 29, and four years later became general manager of the Pittsburgh Wire Co. This company was subsequently taken over by the American Steel & Wire Co., one of the present subsidiaries of the Steel Corporation. Later Mr. Farrell became foreign sales agent. His next step upward was the presidency of the United States Steel Products Co., another subsidiary of the so called Trust, to which he was elected in 1903. He became president of the parent corporation, his present position, in 1911.

❖

The reappearance of the name of A. O. Brown & Co., in the newspapers a few days ago recalls how they were victimized by the salting of a placer in Santo Domingo. In that case the salter appears to have carried off his game. That does not always happen, however, and now and then the would-be salter gets what he deserves. Some persons once became interested in a placer in Oregon, about which they were very enthusiastic, but they paid attention to a recommendation of a friend that they would do well to secure some expert advice and employed J. P. Hutchins, who lately has been operating in Russia. Mr. Hutchins arriving on the ground became suspicious that his clients' samples had been salted and that his own were also to be salted. Being on his guard he was successful in catching the salter in *flagrante delictu*. It is needless to dilate upon the unpleasant things that were discussed in this connection. The terms finally agreed upon were the return of all money paid on account, plus interest, plus all traveling and other expenses incurred by the purchasers, including their engineering expenses. If anybody be going to do a salting job it is not good to be caught in the act.

❖

The conditions under which convict and negro labor have been employed in some mining and metallurgical operators in the South has often been disgraceful, as is well known. James A. Farrell, of the Steel Corporation, told something of this in his testimony a few days ago. "Was the Tennessee Coal & Iron Co. being operated at a profit, when acquired by the Corporation?" asked C. A. Severance, counsel for the Corporation. "No," replied Mr. Farrell. "What sort of labor did it employ?" "Colored labor, and some convict labor." "Has the convict labor been continued?" "It has been entirely done away with." "How many convicts did they employ on their contract work?" "About 700." Mr. Farrell explained that the Tennessee Coal & Iron Co. had been saving $150,000 a year by what is known as the "wage-shaving system." "What is the 'shaving system'?" "The regular pay-day was every two weeks, but the paymaster would call around between times. He would pay off the help with a discount of from 10 to 15%." "Was that the system in that section?" "It was the common system there." "Has it been discontinued by the Steel Corporation?" "It was immediately discontinued when we took hold."

❖

The final inevitable consumption of wood and coal supplies, and the complete development of our water-power resources, may some day, lead the world to look to sources of supply up to now practically untouched. Neglecting the stored fuel energy of combustible sulphides, there would be left for exploitation the stored energy in the revolving earth, manifested through the tides, and what may be termed the contemporaneous solar energy. Of this latter there would remain, after the water power, winds, waves and direct sun energy. Of the tide motors, wind motors, wave motors and solar motors, the last would seem to be the most easily developed for the purposes of mankind. Not a few attempts have been made to use sun motors, but with little or no practical success. Recent experiments in Egypt indicated mechanical difficulties of a rather minor nature, however. In such a power-developing project, as in the case of the other three motors noted, the great question is the intermittent supply of energy. Our present methods of power storage are expensive in first cost, and not economical in operation. It is evident then that sun motors would reach their highest efficiency in a climate where more or less constant sunshine prevails during the daylight hours, such as northern Africa, the southwestern United States, northern Mexico, etc. It is conceivable that under such conditions the desert regions instead of being the waste places of the earth may be made to support large populations, and be counted among the most valued possessions of any nation.

Copper Production of the World

The following estimate of the copper production of the world for three years past is made by Messrs. Aron Hirsch & Sohn, of Halberstadt, Germany. The figures are in long tons of 2240 lb.:

	1910	1911	1912
United States	482,200	487,300	557,590
Mexico	58,800	54,050	71,980
Japan	50,000	55,000	65,000
Spain and Portugal	53,000	55,000	58,000
Australia	43,400	44,600	45,500
Chile	35,800	29,600	37,000
Canada	22,500	24,000	33,500
Russia	22,300	25,500	33,000
Germany	28,800	30,500	30,510
Peru	26,000	26,000	27,400
Sweden and Norway	7,000	9,500	10,000
Cape Colony	7,000	7,000	7,000
Servia	.....	.....	6,000
German Southwest Africa	.....	.....	6,000
Austria Hungary	2,250	2,520	3,960
Italy	3,000	3,000	2,350
Bolivia	2,500	2,500	2,000
Newfoundland	2,100	2,100	1,000
Turkey	1,500	700	500
Other countries	9,000	10,500	10,000
	857,150	869,370	1,008,290

The production of Servia and German Southwest Africa was included under the head of other countries up to last year.

Merton & Co.'s Estimate

Another statement of the world's copper production is furnished by Henry R. Merton & Co., of London, whose long experience enables them to estimate very closely. The figures are in long tons, of 2240 lb. each.

COPPER PRODUCTION OF THE WORLD
(Henry R. Merton & Co.)

	1910	1911	1912
United States	484,935	483,865	554,835
Mexico	61,515	60,905	70,845
Canada	25,715	24,930	34,710
Newfoundland	1,080	1,155	540
Cuba	3,475	3,695	3,935
Total North America	576,720	574,550	664,865
Argentina	300	1,020	330
Bolivia	2,500	1,800	1,850
Chile	35,235	29,595	37,305
Peru	26,945	28,050	27,165
Venezuela	.....	.....	1,340
Total South America	64,980	60,465	67,990
Austria	2,130	2,440	3,860
England	450	400	400
Germany	24,710	22,010	23,920
Hungary	110	85	100
Italy	3,220	2,600	2,300
Norway	10,425	9,425	10,980
Russia	22,310	25,310	33,010
Servia	4,845	6,885	7,240
Sweden	2,000	2,000	1,500
Spain and Portugal	50,255	50,930	58,930
Turkey	600	1,000	500
Total Europe	121,055	123,085	142,740
Japan	46,000	55,000	65,500
Africa	15,205	16,980	16,370
Australasia	40,315	41,840	47,020
Total	864,275	871,920	1,004,485

According to this estimate, 66.2% of the world's copper supply last year was from North America; 6.7% from South America; 14.2% from Europe; 6.6% from Japan; 1.6% from Africa; 4.7% from Australia. The United States alone furnished 55.2% of the total.

There is very little difference between the totals of these estimates, and neither of them varies in any important degree from that given by the JOURNAL in January last.

Butte & Superior

The Butte & Superior Copper Co. has issued its first annual report, covering the year ended Dec. 31, 1912. This is an elaborate document, and is interesting by reason of its description of the property, but it fails to communicate most of the information that we should like to have, probably for the reason that the management does not yet feel itself surely on its feet.

The quantity of ore blocked out is given as approximately 1,200,000 tons, averaging 21.7% zinc and 7.9 oz. silver. The new mill is of approximately 1200 tons, daily capacity. A recovery of 80% of the zinc of the ore is now being made regularly. No income account is given, but a statement of assets and liabilities shows the company to have a surplus of about $563,000.

Strike at Mount Hope Iron Mines

The strike at the Empire Steel & Iron Co. plant at Mount Hope, four miles from Wharton, N. J., started Mar. 24, soon after the employees of the Richard mine at Wharton had struck for shorter hours and higher wages. The Empire company employees demanded an increase of 20% in wages, an eight-hour day, and the recognition of the Western Federation of Miners. This demand being refused, 275 mine workers went out on strike, about 70 to 80 men continuing to work.

At a conference, Apr. 18, the men's requests were submitted. The company in its answer to the men declined to recognize the union, and stated that no advance in wages was possible, since a voluntary increase was made Jan. 15. Assurance was given, however, that after the extensive improvements now under way are completed, the question of further increase in wages would be taken up. The company was willing to grant a fortnightly pay day, and to give proper notice for vacation of houses, and stated that trading at the company's stores had always been optional, and that credit had been regularly extended. It refused to discharge the men then in its employ who had refused to strike.

At midnight, May 13, the Mount Hope Mineral R.R., which had been tied up for weeks on account of the strike, was dynamited in three places simultaneously. Three hundred feet of track was destroyed. The company representatives declared the work was that of strikers, angered because the conference had failed to bring the strike to an end. The section gang of the railroad quit work, fearing that if they undertook to repair the track the strikers would attack them. This railroad is controlled by the Empire company and connects with the Central R.R. of New Jersey and the Lackawanna road at Wharton.

After this incident the company called upon Governor Fielder for aid, and 65 deputies were sent to the mines, May 14, but as there was no disturbance they went away that night. Another portion of the road was blown up the night of May 15, and further deputies, numbering about 200, were sent to the mines and trouble was started at once; finally the strikers succeeded in driving out the deputies. The governor visited the district, but refused to call out the militia, a private detective agency claiming that such action was unnecessary and that it had arranged with the Empire Steel & Iron Co. to cope with the situation, and that no trouble was anticipated by it in establishing order.

The company has lately demanded protection from the sheriff and chief of police for the men it will put to work clearing away the wrecked engine and cars that it attempted to operate the night of the first blowing up of the Mount Hope line. There are several cars of ore that

the company is anxious to ship, but while the authorities replied that they would give all protection in their power to men employed in clearing wreckage and repairing the roadbed, they could not guarantee to guard the line if an attempt were made to operate it. No settlement of the strike seems imminent.

According to observers, the student of war could several times have found ample material for extensive study during the strike, as several pitched battles were fought, with all the accompaniments of assault, ambuscade and sortie. The casualties are difficult to ascertain, as the severe fighting occurred at night. Searchlights proved of great value to the defense.

Albert F. Holden

Albert F. Holden died at Cleveland, Ohio, on May 8, at the age of 46 years. His home was at Cleveland, where his family has been prominent for many years. Mr. Holden graduated from Harvard in 1888. While he was a student at Harvard, he also took some engineering courses in the Massachusetts Institute of Technology. Immediately after his graduation he went to Utah, where his father had extensive mining interests in the Bingham district, and gradually he took charge of all of them, these including the Old Telegraph and Niagara mines. He became an expert mine manager and millman and operated the properties in his charge in a highly efficient way.

In 1898-99 he became associated with Messrs. Clark, Coolidge and Cole, of Boston, in the organization of the United States Mining Co., which took over properties in the Bingham district of Utah and became the nucleus of the present United States Smelting, Refining & Mining Co. During the remainder of his life, Mr. Holden was identified with this company and allied interests. At the time of his death he was managing director of the U. S. Smelting, Refining & Mining Co. He was president of the Island Creek Coal Co. and had a large ownership in the Alaska Gold Mines Co., and the Pond Creek Coal Co., in both of which he was a director. He was associated with D. C. Jackling in bringing out the Alaska Gold Mines Co. Mr. Holden was also interested in newspapers, having been owner of the Cleveland *Plain Dealer* for many years and at one time, a few years ago, part owner of the Boston *Traveler*. During his short and brilliant career he accumulated a large fortune, which is estimated at between $4,000,000 and $5,000,000.

William H. Coolidge, of Boston, with whom Mr. Holden was associated for nearly 25 years, has paid the following tribute to his friend, which is, we believe, an accurate statement of Mr. Holden's qualities and versatilities:

"Bert" Holden was the brainiest man I ever knew. He could talk learnedly on all natural sciences, geology and botany with Harvard or Institute of Technology professors. He could discuss psychology and other abstruse and philosophical subjects with equal facility.

He made money because he considered money making a science. He had absolute confidence in his own judgment, and when last fall he was told that he had but one chance in a million of getting well, he arranged his financial affairs, telling his trustees that he believed his own judgment was better than theirs as to the properties in which they should invest.

No man is infallible and he made mistakes, but he never made the mistake of recommending to his associates the purchase of any property that did not turn out well. Some properties which have turned out valuable did not recommend themselves to him, but those which he did invest in have all proved the soundness of his judgment.

With all the energy that he devoted to his business affairs, he played with equal zest. He had probably the best private collection of minerals in this country; birds' eggs, coins, Bacon-Shakespeare literature, were all equal fads of his. He often said that he would like to spend his time on geological and mineralogical investigations for Harvard as did Professor Agassiz.

He knew the newspaper business and was largely interested in the Cleveland "Plain Dealer" and other papers. He was very retiring by nature, refusing at all times when possible to have his name or his picture appear in the public prints.

Graduated from Harvard in 1888, he was a Phi Beta Kappa man, standing almost at the top of his class. He was captain of the University foot-ball team; played upon the University base-ball team and was a member of the University track team at Mott Haven. While in college he also took courses in the Institute of Technology, and at one time played upon the Institute foot-ball team.

Every summer during his college course he spent in the mines, and until he joined with some of his Boston friends in the properties with which his name has been associated here, he had spent his entire time in Salt Lake City, where he had become a recognized mining expert. Mining lawyers of the West considered Mr. Holden a better mining lawyer than any of the legal profession. A strong man, he had intimate friends and bitter enemies, but knowingly he never did any person an injustice.

The Latest Geological Survey Fire

WASHINGTON CORRESPONDENCE

No surprise was expressed in Government circles at the occurrence which, on May 18, caused a larger loss to the U. S. Geological Survey than it has experienced in any of its previous four fires during the past six years.

The loss is estimated at $150,000, of which $100,000 falls on the Survey, but it is claimed that much of this loss represents destruction of documents, records, maps, charts and field notes which practically cannot be replaced as they represent the individual work of investigators of the Survey, who cannot restore what has been done in the past without going over the same ground again, which requires years of work as well as a large outlay. The fire did not originate with the Survey, but in an office underneath it. For several years past there has been a demand for appropriations to build a fireproof building for the Survey, and such a building was finally authorized last winter, but no appropriation was made to provide for it. Probably great interest in the subject will now be taken by members of Congress. The suggestion is already made that it would be well to pass an emergency appropriation without further delay, so that the Survey may be adequately provided for and further loss of the same sort avoided.

Reported in New York

It is said that the International Agricultural Corporation has found its sulphuric-acid contract with the Tennessee Copper Co. to be unprofitable and burdensome and will seek a modification thereof, to which it is believed the Tennessee Copper Co. will consent.

Labor agitators are said to be trying to create disturbance among the brass mills in Connecticut.

A New Smelting Plant for the Ashio Mines as designed by Kosaku Asano, and described by him before the New York Section of the American Institute of Mining Engineers, will overcome the flue dust and fume problem by: (1) Cooling the stack products by radiation; (2) settling the dust in chambers with the aid of suspended bamboo; (3) diluting the gases to bring the SO_2 content to a low point; (4) scattering the fumes by the use of three or four stacks.

PERSONALS

Philip Argall, of Denver, Colo., is visiting in New York.

W. E. Berb has been appointed chief engineer at the Minnequa works, Pueblo, Colo., of the Colorado Fuel & Iron Co., Denver.

J. J. Stone has been elected president of the Iron Mountain Mining Co., Duluth, Minn. He succeeds William Brown, who resigned.

Percy E. Barbour, manager of Uwarra Mining Co. at Candor, N. C., has been in Chicago buying machinery for the mine, and has just returned to Candor.

W. Crasts, metallurgist, president of the Crucible Steel Forge Co., Cleveland, has left for an extended tour of Europe, during which time he will visit the leading electric steel plants.

Dr. John C. Branner, vice-president of Stanford University, has been made president of that institution, succeeding David Starr Jordan, who has become chancellor. Doctor Branner is now in Brazil, acting as geologist to the Brazil government.

C. L. Dake has been appointed assistant professor of geology and mineralogy in the Missouri School of Mines. He has served as instructor in the University of Wisconsin and at Williams College, and has had an extensive experience in geological field work in the Lake Superior district.

Dr. D. D. Cairnes, of the Canadian Geological Survey, has left for the White River district, Yukon Territory, where he will be engaged in field work during the summer. This district is now engaging the attention of prospectors on account of the occurrence of native copper.

Louis Ross has returned to Boston after an absence of four months in England discharging his duties as director of the Ferrobamba, Limited, an English company having a few large American stockholders. Mr. Ross delivered an address on Wednesday evening, May 21, before the members of the Mining Engineering Society of the Massachusetts Institute of Technology on the atacamite ore deposits of Chuquicamata. Mr. Ross reported on these deposits in March, 1911, and secured long time options on practically the entire acreage covered by the "Hamperas" (the friable ores containing the oxychlorides of copper). He was the engineer who first brought these mines to the attention of the Guggenheims.

OBITUARY

Owen Biglen died at Lewistown, Mont., May 10. He had been engaged in mining in the state for many years, with the exception of 10 years, which he passed in South Africa.

William J. Stevens was killed at Garfield, Utah, May 7, being caught under a carload of slag. He was 66 years old and was one of the oldest smeltermen in the state, having worked at the old Sandy smeltery, when the smelting industry was launched in Utah. Later he went to Frisco and Pioche, finally becoming identified with the smeltery at Eureka, Nev., in 1881. He served as superintendent of this plant until 1893 when he returned to Utah to take a position with the Germania smeltery at Murray. Mr. Stevens remained with the American Smelting & Refining Co., when this plant was taken over. Six years ago he was transferred to the Garfield plant.

Frank O. Briggs, for many years connected with the firm of John A. Roebling's Sons Co., engineering contractors and suspension bridge builders, of Trenton, N. J., died May 8. He was born, 1851, and graduated from the United States Military Academy at West Point, N. Y., in 1872. He resigned from the Army five years later to enter the employ of the John A. Roebling's Sons Co., builders of the Brooklyn Bridge. He had been assistant treasurer of the company since 1883. Mr. Briggs was Mayor of Trenton from 1899 to 1902, a member of the State Board of Education 1901-1902, State Treasurer of New Jersey, 1902-1907, and in 1907 he was elected United States Senator from New Jersey, his term expiring Mar. 4 last.

Benjamin Romaine Western died in Brooklyn, N. Y., May 1, aged 73 years. Mr. Western, in connection with his brother Charles C. Western, in 1866 started the "American Mining Journal," which later became the "Engineering and Mining Journal" and was its publisher until he sold it to Richard P. Rothwell and Rossiter W. Raymond in 1871. He was for many years well known in the advertising business, at first as Western & Co., later as the Manufacturers' Advertising Bureau and finally as the Manufacturers' Publicity Corporation, of which he was president and treasurer up to the time of his death. He also started some other papers, including "The Coal and Iron Record" and the "Manufacturer and Builder." Few men had a wider or more thorough acquaintance with the advertising field in the line of machinery and manufactures.

Walter Guy Martin, who died at his home in Denver, Colo., Apr. 27, was born in Maryville, Mo., July 25, 1873. After finishing high school at Muscatine, Iowa, he entered Purdue University in September, 1892, and graduated June, 1895, receiving the degree of bachelor of mechanical engineering, which included a special course in electrical engineering. In 1896 Mr. Martin graduated from the Missouri School of Mines at Rolla, Mo., as mining engineer. On Mar. 17, 1900, he was married to Miss Flora L. Johnson, of Rolla, Mo. At that time Mr. Martin was superintendent of the Snow Bank Mine of Kokomo, Colo., and was in close touch with the mining and milling operations of the West. He always took a decided interest in chemistry, metallurgy, mining, and milling, filling several responsible positions along these lines until his health failed a few years ago.

Tom Johnson, a prominent member of the Chemical, Metallurgical and Mining Society of South Africa, died at Johannesburg, Transvaal, aged 46 years. He was born in England and began work as a coal miner. He was a member of the Institution of Mining Engineers, as well as of several minor societies, and held the mine manager's certificate (Transvaal) and a first-class colliery manager's certificate (England). At the early age of 25 he held the position of manager of the Snow Hill and Crop Side pits, near Bolton, England. Mr. Johnson went to South Africa in 1893 and was for some time assistant manager of the Albion Gold Mines, Barberton; moving to the Rand he was for a long time mine captain at the Geldenhuis Deep, Ltd., and his services in that capacity were so successful that in 1904 he was appointed manager of the Rose Deep, Ltd., and in 1907 was transferred to the South Nourse, Ltd., in a similar capacity. After the amalgamation with the Nourse Mines, Mr. Johnson took a lengthy holiday, a great portion of which was spent in studying mining conditions in various parts of Europe. On returning to the Rand in 1909 he was appointed underground manager for the Transvaal stope-drill competition and latterly held the position of assistant manager of the Ferreira Deep, Ltd. During the war he served with the Ambulance Corps in Natal for a period and his services were later in the war requisitioned by the military in an engineering capacity. He was a close student of the conditions of the miners on the Rand and their possible improvement.

SOCIETIES

Case School of Applied Science—This school at Cleveland, Ohio, has inaugurated the publication of a mining and metallurgical quarterly, known as the "Case Mining Quarterly."

Michigan College of Mines—The classday exercises were held at the gymnasium on April 24. Dr. J. A. Holmes, director of the United States Bureau of Mines delivered the address. Dr. Holmes talked on conservation and made a strong plea for closer coöperation between the individual and the federal government in an effort to check the waste in the exploitation of mineral resources and for better conditions in mining. He enumerated the various obstacles encountered in the pursuit of the work of the bureau of which he is in charge. The lecture was illustrated by a magnificent set of steropticon views showing the various branches of the work carried on by the bureau. The 1913 class banquet was held at the Douglas House on April 25. Covers were laid for 48. W. A. Richelson acted as toastmaster and Wm. Kelly, chairman of the board of control, responded, as did C. E. Chaffin on "Our Alma Mater"; E. W. Becker, on "Crosscuts to Success"; President McNair on "Dope"; H. G. St. Clair on "The Faculty," and Professor Fisher on the Alumni Association. A course in Spanish is the latest innovation being considered at the college. W. L. Cumings of the Bethlehem Steel Co., a graduate of the college, has collected figures, showing that 20% of the graduates are employed in Spanish-speaking countries and that another 20% have work in these countries. The course proposed is a two-year course, one hour a day, five days in the week, the teaching advocated being a conversational method.

EDITORIAL CORRESPONDENCE

SAN FRANCISCO—May 15

Lightner Gold Mining Co. has failed to make the second payment of $50,000 and the ownership of the mine and mill has reverted to the Lightner Mining Co., the original owner. Extensive improvements were made, the shaft deepened and some good oreshoots disclosed at the lower levels by the Lightner Gold Mining Co. The 60-stamp mill was operated for a time, and the indications last spring were that the development would warrant the resumption of milling. The actual cause of the failure to complete the purchase of the property after paying $50,000 on the purchase price and making large expenditures has not been made public. It is believed by some that there is still a future for this old mine, and it is said the owners will again undertake its operation. It is probable that only 20 stamps will be put in commission at the start. The mine and the mill are in good condition.

Selby Smeltery Smoke Inquiry will be aided by Dr. J. A. Holmes, director of the U. S. Bureau of Mines, during his visit to California in May, when it is expected that the organization of the commission selected by the supervisors of Solano County for the investigation of the complaints of farmers against the Selby smeltery, will be effected. Dr. Holmes will also visit Shasta County to inquire into the complaints of the farmers against the Mammoth smeltery. It is understood that he will visit the Balaklala as well as the Mammoth plant. The commission selected by the supervisors of Solano County is to be composed of Doctor Holmes, Doctor Snow of the state board of health and Doctor Gould, who was employed as determinative chemist by the farmers' association of Shasta County in former investigations. It is probable that the same commission may be selected to act in Shasta County. The district attorney has recently issued a formal opinion advising the board of supervisors that an appropriation cannot be legally made to aid the farmers' protective association in their fight against the smelteries. This opinion was known prior to its formal issuance, and this knowledge was the excuse for the grand jury declaring the Mammoth smeltery a public nuisance and recommending its abatement to the district attorney. The grand jury might have found an indictment against the Mammoth, if there had been sufficient evidence to prove the charge. The fact that the evidence was lacking left the jury only the alternative of creating an impression against the smeltery. It is not at all likely that the supervisors or the district attorney will heed the recommendation of the grand jury; but that will not end the trouble. The annoyance of the smelters will continue until some definite plan is adopted for positively determining whether or not any actual damage is being done to the lands and the crops of the farmers. It is believed that the plan adopted by Solano County will be effective and that the same plan may also result satisfactorily in Shasta County if the supervisors adopt it.

Four Mine-Regulation Bills introduced in the fortieth session of the legislature, which adjourned on May 12, were defeated. Three other bills, directly or indirectly affecting the mining industry, were passed. The defeated bills were drawn to provide for: The regulation of gold dredging by a water commission with power to grant or refuse permission to dredge any lands, and to regulate the type of dredges to be employed; the appointment of a mine inspector and provision of safety appliances and regulation of underground and surface operations; a special type of water drill for the prevention of dust in drilling; and the modification of the 8-hr. law in its application to miners, requiring that the eight hours begin and end at the collar of the shaft or portal of the tunnel. The bills that became laws are: The water-commission act; the workmen's-compensation act, and the alien-land act. The defeat of the bills aimed directly at the mining industry was due largely to the personal activity of men directly interested financially in mining. There are acceptable features in three of the four defeated bills and with proper amendment these bills might have been passed. There is no question as to the necessity for mine inspection and moderate regulation of underground and surface equipment and operation of deep mines, nor is there serious objection to what is known as a "dry-hole" law; but the enactment of such laws as were introduced in the legislature, without amendment and modification, would have worked a costly hardship on mine owners without accomplishing the desired results. The gold-dredging act was objectionable from every point; there is no reason or excuse for the passage of such a law. The water-commission, the workmen's compensation, and the alien-land laws will all have a tendency to discourage development and small mine operations. This is particularly true of the water-commission law, as it affects the use of water for the generation of electricity. The workmen's-compensation law is objectionable for the reason that it permits no appeal except to the appellate and the supreme court, and provides that compensation shall be paid to the state for the death of an employee who leaves no dependent to collect the money. Compensation for the death of an employee must be paid regardless of the cause of the accident. The alien-land bill will probably cause to be withheld large amounts of money that otherwise would, as in the past, be invested in mines.

DENVER—May 16

The First Carload of Ore from Eagle was shipped May 10 by E. F. Bounell, manager for the lessees of the Lady Belle mine. It was consigned to the smelters at Salida and it is reported that it assays over 200 oz. silver per ton. In honor of this initial shipment, a Good Roads convention, attended by 1000 men, was held, followed by a banquet and ball in the evening.

The Doctor-Jack Pot mine in the Cripple Creek district has taken over the adjoining properties of the Work company to satisfy a judgment rendered in its favor by the U S. District Court. The ownership of the richest shoots of ore, which are between the two properties, has been the subject of litigation for some time but now that the court has given the title to the Doctor-Jack Pot, this ground will be rapidly opened.

The Gold Strike at Jasper, 32 miles from Monte Vista, has caused a rush of miners and prospectors, and it is said that at least 500 men have settled in the district already. The strike was made in the Miser mine and the vein is stated to be about 12 ft. wide and carries a rich streak of free gold and sylvanite. A rate of $7 has been made by auto from Alamosa to the new mining camps, Jasper, Stunner and Gilmore, north and east of Platoro. Shorter time can be made to these camps from Alamosa than from any other place on the Denver & Rio Grande R.R.

SALT LAKE CITY—May 15

At the International Smeltery at Tooele, eight furnaces are in blast, four on copper ores, and four on lead ores. The chief source of copper ores is the Utah Consolidated at Bingham, from which property lead ores also are received. The South Utah in Beaver County has made shipments from time to time. During April this company shipped 10 cars of concentrates produced from operating the mill about three days per week. It is understood that the Miami concentrates will be shipped to the International until a clearing up of the Mexican situation allows resumption of shipments to the Greene-Cananea smeltery.

A Strike of Interest has been made recently at Park City. The Silver King Consolidated in sinking its main shaft from the 1300- to the 1800-ft. level cut high-grade galena-carbonate ore. The entire bottom of the shaft, two compartments and a manway, is in this material, and the extent of the ore is not known. The strike is noteworthy in that it opens ore at depth on the dip of the orebearing limestone beds, in the northwesterly part of the camp beyond the proved ore zone. Important oreshoots including the Parson's and Jewell stopes in the neighboring Silver King Coalition adjoin this newly opened territory on the south.

GLOBE, ARIZ.—May 14

The Graham Mine Tax Bill passed the legislature by two-thirds vote May 14, and was to be signed by Governor Hunt the same night, he having sent a message to the legislature the day previous urging the passage of the bill. Producing

mines are valued at four times their net profit plus one-eighth the gross product plus value of improvements. The bill will raise the valuation of all mines from the $45,000,000 of last year to $125,000,000 this year.

A New Smeltery in the Verde Valley is being built by the United Verde company of Jerome. The branch railroad from Cedar Glade on the Santa Fé, Prescott & Phoenix R.R. running through the Verde valley for 40 miles to the site of the smeltery, has been completed. The preliminary work for the smeltery, including the grading, foundations, etc., is well advanced, and the steel work will be begun some time in July. The orders already placed call for 9000 tons of structural steel, and the progress in the erection of the buildings will depend somewhat on the promptness of deliveries of material. However, the officials expect that the first unit will be ready to blow in about this time next year. The capacity of the new plant will be approximately 3000 tons per day. The plant will consist of four blast furnaces and three reverberatory furnaces, the dimensions of each of the last being 19x104 ft. The plant has been designed with the view of its enlargement, should it be deemed necessary or advisable. All ore will be dropped to the 1000-ft. level of the mine, which is tapped by a tunnel several thousand feet long through which the ore will be conveyed by electric tram and delivered into bins at the portal of the tunnel. From there it will be hauled in cars over a standard-gage railroad 6 miles to the smeltery. The smeltery and tunnel will be controlled by a company to be known as the Verde Tunnel & Smelting Co.

WALLACE, IDAHO—May 14

The Mineral Output of Shoshone County according to the report of the county assessor was worth $15,391,098 for 1912. This amount is all from the Coeur d'Alene district. The ore mined during 1912 amounted to 1,888,244, tons which yielded the above gross value. The total cost of mining is given as $5,926,374 and the total cost of reduction, including milling, transportation, and smelting, $5,095,617. In addition to these costs the companies spent $900,786 in betterments and repairs to the mines and mills, leaving a total net profit of $3,589,501. The producing properties which this report covers are the Alice, Bunker Hill & Sullivan, Caledonia, Federal (operating the Standard at Mace, the Morning at Mullan, and the Last Chance at Wardner), Gold Hunter, Green-Hill Cleveland, Hecla, Hercules, Marsh, Ontario, Snowstorm, Stewart, Success, Surprise, Tamarack & Custer Consolidated, Tyler Lease, and Interstate-Callahan. Only three of these properties show loss in operation, the Caledonia on account of litigation, the Marsh on account of only a short period of operation, and the Gold Hunter on account of extensive development work which has been going on at the mine. The above figures show that the gross yield per ton or ore mined was $8.15, the cost of extraction, $3.14 per ton, the cost of reduction, $2.66 per ton, the cost of improvements, $0.45 per ton, and the net profit $1.90 per ton.

COBALT—May 20

A Verdict for $416,250 was awarded yesterday to George Niner in the Supreme Court of Kings County, in the State of New York, being one of the largest awards ever made in the state against an individual or group of individuals. Niner brought suit as assignee on behalf of Charles B. Flynn, a prospector. The defendants were Payne Whitney, Bernard M. Baruch, Clarence K. McCornick, Willis McCornick, William H. Brevoort, Thomas Raborg, George Martin Luther, and Samuel Newhouse. Counsel for the defendants moved to set the verdict aside as contrary to the weight of evidence, and Justice Benedict allowed two weeks for the filling of briefs.

It was stated by Flynn's representative that Flynn in 1906 interested Brevoort and the McCornicks in claims he had found at Cobalt and engaged with them to examine and report on all the properties in the district. The arrangement was that if he recommended any of the properties for purchase and his reports were confirmed by engineers to be sent to Cobalt for the purpose, he was to receive in stock 10% of the profits of any syndicate Brevoort and the McCornicks might form to put the property on the market. The agreement was not in writing and the defendants denied that such an agreement was made. On Flynn's reports Brevoort and the McCornicks, according to the testimony, bought the Colonial mine for $650,000, formed a syndicate and capitalized the property for $5,000,000 in sharts of $1 each. Enough stock was sold to the public to pay for the property and to furnish working capital. The rest of the stock was the profit of the syndicate and they delivered to Flynn 95,000 shares. In the suit they contended that this was not 10%, but at the time he supposed it was. Flynn also recommended the purchase of the Watts King mines, on which he obtained options, and which are the properties involved in the suit just decided. While his negotiations were in progress Brevoort said he would take charge of them. He did so, and purchased the properties. They were taken over by a syndicate consisting of all the defendants for $890,000. They formed a company, known as the King Edward Silver Mines Co., capitalized at $6,000,000 in $5 shares. Of these 400,000 shares were offered to the public at $2.50, and they were oversubscribed five times in one day. This supplied $1,600,000, which paid for the property and provided $110,000 for working capital. Two hundred thousand shares were put in the treasury and the rest of the 600,000 shares were the profit of the syndicate. Flynn demanded 60,000 shares as his 10% of the profit, but was refused, and he sued for them. The jury's award is for the full amount at the value they had at the time when he was entitled to receive them, namely, $5 per share. This amounts to $300,000, and the interest since 1906 brings it up to $416,250. Flynn contended that the reason the defendants refused to deliver the shares was that his possession of them would interfere with their plans for forming a pool and manipulating the stock in the market.

TORONTO—May 17

Changes in the Canadian Tariff were announced by Hon. W. T. White, Canadian Finance Minister, May 12. The movement on the part of the iron and steel trade for additional protection as a compensation for the abrogation of the iron and steel bounties, proved ineffectual in the face of the determined opposition of the Western provinces to any increase in duties, and such minor changes as were made relating to manufactures were reductions. Type-casting and setting machines, traction ditching machines for farm work, and miner's rescue appliances were placed on the free list. A slight reduction was made in the cement duty, which was reduced from 12½c. per 100 lb. to 10c., which is regarded as likely to affect adversely the small independent manufacturers. The lead bounties which would otherwise have expired automatically have been continued for another five years.

Case of the Gray's Siding Mine has just been dismissed on an appeal to the supreme court at Ottawa. The mine is on the Timiskaming & Northern Ontario Ry., near Cobalt. A considerable tonnage was shipped from the property, but the mine proved unprofitable. The appellants were William Marshall, an English engineer, and the Gray's Siding Development, Ltd., and the respondents, R. G. Leckie, of Sudbury, and the Montreal Trust Co. In May 1908, Leckie granted an option to Marshall for $250,000, $12,500 to be paid in consideration of the option but to count as part of the purchase price on completion. A further $37,500 was to be paid May 6, 1909 and the remaining $200,000 in half-yearly intallments. The vendors claim that the option had been taken up and an agreement to purchase resulted and they brought action to have specific performance declared. The purchasers contested this on the grounds that the agreement was not binding, and that several of the titles to the mining locations were defective. Several judgments were rendered in the Ontario courts on the issues and a reference was made to the Master on the question of title, and on an appeal to the Judicial Committee of the Privy Council, these judgments were confirmed in favor of Leckie and the case was subsequently proceeded with in the Ontario courts. The appeal was dismissed with costs.

PORCUPINE—May 17

The Sandy Falls Power Plant, will have one unit in operation, it is expected, by the end of another week, and a week later, one unit should be available at Wawaitin Falls. This will give a total of 2500 hp. At the last plant, it was found necessary, in order to make quick repairs, to use portions of both penstocks to get one unit in commission. The work of installing another penstock will be carried on as rapidly as possible.

Increasing the Dome Mines Capital from $3,500,000 to $5,000,000 will be voted upon at a special general meeting of the shareholders to be held at the head office of the company, at Toronto, May 27. The increased capitalization can be used for the sole purpose of providing funds for additions and extensions to the company's mill or the erection of a new mill and other buildings and equipment which may be needed. The $500,000 which will be realized from the first sale of 50,000 shares will be used in adding another 60 stamps to the mill. In a letter to the shareholders Ambrose Monell, the president, reports that there is 315,528 tons of an average value of $7.53 developed above the 45-ft. level. In addition, there is 250,000 tons developed between the 45- and 160-ft. levels which at present is not capable of close valuation. In addition, diamond drill results and developments east of the present workings, indicate other shoots of ore.

THE MINING NEWS

ALASKA

Innoko District

THE NEW CRIPPLE CREEK DIGGINGS give promise of producing. About 100 people are in the camp. Pay has been found on five claims on Cripple and Colorado Creeks. The ground is shallow and will be worked in opencuts during the coming season. The section between the north fork of the Innoko River and the Ruby district is also looked upon as favorable for prospecting.

Juneau District

ALASKA-JUNEAU—The crosscut tunnel has been advanced to the 6000-ft. point, crosscutting the vein at a depth of about 2000 ft. below the outcrop. The first 150-stamp unit of a new mill is under construction on the beach west of and adjoining the town of Juneau. It is expected that this unit will be ready for operation in the autumn, when test runs on the ore cut by the tunnel will begin. During the autumn and winter the work will be largely experimental in order to determine the grade of the ore. The test work will be done also on ore from several crosscuts besides the long tunnel. In addition to the crosscutting a raise will be put through to the surface, crosscutting the vein from the foot wall to the hanging wall. All the ore so excavated will also be milled to determine its average grade. With the information thus gained as a basis, final plans will be made for the ultimate plant which will be of large capacity. F. W. Bradley, of San Francisco, is manager.

ARIZONA

Cochise County

COPPER QUEEN—The top slicing method of mining is gaining in favor in the mines in the Warren district. In the Czar mine that method of mining is being continued from the 400 to the 200 level. In the Neptune shaft the work has just been started and good progress is being made in its introduction. Its most extensive application will be in the Sacramento mine in which it is to be introduced soon.

Maricopa County

IN THE AJO DISTRICT to the south of Gila Bend some old mines are being reopened and newly discovered veins are being developed.

A DISCOVERY OF COPPER AND SILVER in the Mazatzal Mountains is reported by Bowman & Murphy who discovered cinnabar near the old Sunflower ranch in this region. The late discovery was made several miles distant from the place where the cinnabar was found.

ORO FINO—At this mine in the Winnifred district, about 18 miles north of Phoenix, the shaft is 80 ft. deep, the vein in the bottom being 5 ft. wide.

VULTURE—A motor truck was recently purchased for this mine near Wickenburg. The mill is in continuous operation and shipments of concentrate are made regularly. About 200 men are employed in mine and mill.

MAX DELTA—A new hoist and a compressor are being installed at this mine seven miles south of Phoenix. Sinking will be resumed in the main shaft. This mine has been fairly well developed and the management is considering the erection of a small mill for making tests of the ore. W. S. Jennings is superintendent.

Mohave County

FRISCO—This property is being reopened for the Yuma Mining Co., under the direction of J. E. White, formerly manager of the Quartette mine, at Searchlight, Nev.

FORTUNA—The mill is to be moved to the source of water supply at Gila Bend, near Blaisdell, to obviate the necessity of pumping the water a distance of 15 miles. The ore will be brought to the mill by a new tramway now being installed. H. C. Haupt is managing the property.

Pinal County

MAGMA—Diamond drilling from the 800-ft. level has reached the 1400-ft. point and excellent ore is reported from this depth.

HORN SILVER—A recent shipment of 6 tons returned $10,000. Steps are being taken by Ray men to develop the property more extensively and install modern equipment.

Yavapai County

TIP TOP—A shipment of tungsten concentrates was made recently to Denver.

SILVER CHORD—This mine is again being operated by lessees, who are making small shipments.

SILVER TIP—Callaghan and Black, who are leasing a part of this mine, shipped a carload of ore recently. The owner, J. A. Wells, is making shipments from another part of the mine.

SANTO NINO—The company operating this mine has lately been reorganized and new capital has been enlisted, with the result that development is progressing in good order, and some fine ore has been opened.

SWASTIKA—Shipments of high-grade silver ore from the Silver Prince claim, which was a heavy producer in the '80s, continue to be made. An excellent body of high-grade ore has been developed on the 300-ft. level.

UNITED VERDE EXTENSION—A drift is being driven to a point 1500 ft. east of the shaft, where a raise will be lifted to the surface. A shaft will also be sunk 1400 ft. from this point. Through this new shaft the Jerome-Verde, as well as the Extension ground, can be operated.

CALIFORNIA

Amador County

ALPHA—U. S. patent has been received. The property has been under development for the last 20 years. The claim is west of the Central Eureka. It is bonded to San Francisco men.

CLINTON CONSOLIDATED—The injunction suit to prevent the sale of the mine for delinquent taxes has been transferred from the superior court of San Francisco to the superior court in Amador County.

BUNKER HILL—A miner was killed, May 4, by contact with a live electric wire, which connects with the pump on the 800-ft. level. He was found holding the wire with both hands. Other miners forced his hands free with a piece of lagging, but he was dead before being liberated. No reason is assigned for his being near the pump or pump wire or even in the pump house, as his work did not call him there.

KENNEDY—The deepening of the shaft has been completed. The total depth is 3896 ft. Two levels will be opened below the 3450-ft. level. One at 3600 ft. and one at 3750 ft. This will leave a 146-ft. sump. When the shaft is again deepened a new hoist will be installed, as the capacity of the present hoist is rated at not more than 4000 ft. The foundations are being completed for the tailing wheels.

MATICH VS. ORIGINAL AMADOR MINING CO.—Plaintiff as administrator of the estate of Nick Bielick sues for $15,000 on account of the death of Bielick, caused by a caving of rock in the Little Amador mine, on Mar. 10. The complaint is that while working in a chute, and following instructions, he blasted a large boulder that partially closed the entrance. After the blast he returned to the place to resume work and was caught by the cave-in and buried. Wilful neglect on the part of the company in failing to provide a safe working place, it is said may be charged.

SOUTH EUREKA—The drift on the 2100-ft. level, which is being driven to connect with the 1800-ft. level in the Oneida has cut a 6-ft. vein, all the way, the grade of the ore ranging from $7.50 to $20 per ton for a length of about 200 ft. The drift is being driven from both ends and the total length yet to be driven is about 450 ft. The vein corresponds with the 2000-ft. level in the South Eureka, but the ore grades are higher. The disclosing of this ore has given rise to sensational rumors. A $20 ore is exceptional in the Mother Lode region, and if the ore averages $7.50, there will be no hesitancy about starting the 60-stamp mill on the Oneida, which is a part of the holding of the South Eureka Mining Co. The water in the lower levels of the South Eureka, which accumulated during the repairing of the shaft, will soon be out.

Mariposa County

ORIGINAL—Stoping is in progress on the 175- and 400-ft. levels and the 10-stamp mill is operating steadily. Electric power is generated by the company for use in the mill and mine. A winze will be sunk 220 ft. from the adit.

SCHOOL HOUSE—The 2-stamp mill has been put in commission and is now working on ore from the old dumps, from which a good recovery is being made. The property which is being worked under bond by P. G. Gow is in Hunters Valley.

WHIMSHAFT—Unwatering this shaft, which was flooded by the tapping of a large body of water in the old Mariposa workings, has been completed and further development work is contemplated. The company is operating under lease from the Mariposa grant; W. B. Stalder, of Mariposa, is superintendent.

SUNSHINE—A hoist and ore bin have been installed on this property in Whitlock district. Stoping is in progress in good ore on the 100-ft. level. The company has purchased the Johns mill, ½ mile down the cañon, and has installed a 30-ton Monarch roller mill. A battery of two stamps will be used to crush the ore before it goes to the roller mill. Motive power is steam.

TREASURE—This mine was closed down in April, owing to an accident to the air compressor. The foundations are ready for the new Ingersoll-Rand compressor, which is to be installed. It is expected that the mill will be operated regularly as soon as the mine is in full working order again. Drifting is in progress on the first, second and third levels. J. W. McGinn, of Hornitos, is superintendent.

MELVINA—H. C. Kennedy and J. M. Eilbeck have bonded the 25 claims owned by the Merced Gold Mining Co. The Melvina, the principal one, has been unwatered below the 900-ft. level. A vein of milling ore is disclosed at the 400-600- and 900-ft. levels, carrying some gold in the sulphides. Development work is in progress. There is a 40-stamp mill on the properties. Electric power is brought in on a new pole line from the Piñon Blanco mine.

VIRGINIA—Electric equipment has been installed at this property, which has been idle the last three years. A new electric hoist and a station pump at the 400-ft. level are part of the new equipment. It will be 60 to 90 days before the mill will be opened, it being the intention first to install a secondary plant for concentration. Retimbering of the shaft from the adit level to the surface, 95 ft., is in progress. Power is brought in from the Merced River.

CROWN LEAD—A tunnel, 2200 ft. long, has been driven toward the old workings, all but 140 ft. of which was completed May 1. An 8-ft. vein with a shoot of good milling

ore has been encountered. There is in excess of 400 ft. of backs in the old workings. It is expected that the mill will resume operations June 1. The mill, which is on the Merced River, is connected with the mine by a 5600-ft. aërial tramway, which is ready to be put in commission. G. S. Ireland, of Coulterville, is superintendent.

Nevada County

DROMEDARY—The shaft of this mine in the center of the town of Grass Valley, has been cleaned out and retimbered to water level. It is reported that a new electric 300-gal. pump has been ordered, and that an electric hoist is contemplated.

Shasta County

MAMMOTH—It is reported that offers have been made to purchase farms said to be affected by the fumes from the smeltery, but the owners have put prohibitory prices on their holdings. It is believed that the intended visit of Doctor Holmes, director of the U. S. Bureau of Mines, to Shasta County, in the latter part of May, will promote the probability of a reasonable settlement between the Mammoth and the farmers that will avoid litigation threatened by the recent finding of the grand jury, which declared the smeltery a public nuisance.

COLORADO

Clear Creek County

RED OAK—This property, on Donaldson Mountain near Georgetown, was to be sold May 12 at public sale by trustee in bankruptcy to satisfy claims amounting to $14,000. It is probable that the property will be purchased by the bondholders.

SUNNY JIM—This property, owned by the Symmonds Square Deal Mining Co., is on the north side of Lincoln Mountain 4 miles above Empire. The company contemplates active development during the coming season. A large bunk house and blacksmith shop will be built and the property will be efficiently equipped to drive the main crosscut tunnel. The tunnel will intersect four promising veins within a distance of 600 ft. and at a depth of 500 ft. below the surface. Opencuts on the vein outcrops have disclosed galena ore of encouraging quality.

Lake County—Leadville

AT THE ARKANSAS VALLEY SMELTERY the Colorado Power Co. is installing a large electric motor to work the blower and if it proves satisfactory other parts of the plant will be electrified.

NORTH AMERICAN—This mine, on Fryer Hill, is being equipped with machinery by W. J. Davis & Co., lessees, who, commencing about June 1, will sink the shaft deeper.

LOUISVILLE—This mine, on Iron Hill, is producing about 50 tons of iron ore daily from the 365-ft. level below the Yak tunnel. The upper workings will probably be ready to lease by June 1.

STARR PLACER—This property, in California Gulch, is being put in shape for the summer's work as are also the placers of Tennessee Pass. The Starr placer has been worked every season since 1860 and still yields an average of $5 per day per man.

San Juan Region

SUFFOLK—The mine and mill are closed down on account of shortage of ore.

NELLIE—The trail has been opened to this mine in Bear Creek basin. Lessees have resumed operations in the mine and the mill will soon be started.

JUNTA—Grading for the new mill in Bear Creek is in progress. Much of the timber required for the building is on the ground. The milling machinery has been ordered and will be delivered soon.

BUTTERFLY-TERRIBLE—A force of men is employed in the mine, cleaning out old workings and placing the levels in operating condition. The mill has been overhauled and is ready for ore. The property will soon be in operation.

LITCHFIELD—The development of this property in the Mount Wilson district will be resumed. The bunkhouse, which was damaged by snow during the winter, is being repaired and a force of men will be at work in the mine in the near future.

ORO-CASHIER—The crosscut tunnel has been advanced 170 ft. The property has been equipped with a boarding house, blacksmith shop, storehouse and tools. The upper workings are being operated under lease. The company now feels justified in building a small mill, the machinery for which has been ordered.

COLORADO-SUPERIOR MINING CO.—At a recent meeting of the stockholders in Denver, it was decided to either lease or sell the Black Bear property. It is understood that local operators will undertake the development and operation of the property under lease and that production will be resumed during the coming season.

Teller County—Cripple Creek

GOLD SOVEREIGN—A cyanide plant, to treat the old dumps, is being built at this mine, on Bull Hill.

AMERICAN EAGLES—The production of this mine, of the Stratton Estate and leased by the Colorado Mines & Investment Co., a Denver company, is about 14 carloads per month of 2-oz. gold ore. Most of this comes from a depth of 1000 feet.

GOLD DOLLAR—This mine, on Beacon Hill, which began to ship in 1897, is making its usual production of about 1000 tons of mill ore per month. The workings are now below the twelfth level, and it is believed that the water level is about 100 ft. deeper. It is stated that there is enough ore in sight to keep up present shipments for one year. The workings of this mine are chiefly in gneissoid granite, near its contact with the phonolite mass of Beacon Hill.

IDAHO

Bonner County

IDAHO SMELTING & REFINING CO.—The smeltery at Sandpoint, real estate, mining claims, and personal property of this company were recently sold at sheriff's sale to officials of the Union Trust & Savings Bank of Spokane for $250,000. It is announced that the purchasers will either operate the plant or sell it to somebody who will.

Coeur d'Alene District

HIGHLAND-SURPRISE—Work at this property on Pine Creek is to be resumed after an enforced shut-down on account of the high water. A call for bids has been issued for 100 ft. of drifting and 50 ft. of crosscutting. Work will be started at once on the orebody on the Highland side which has improved steadily in size and grade, for the last 50 feet.

SUCCESS—Extensive development work is to be done at this mine on Nine Mile Creek. The shaft is 240 ft. below the level of the main working tunnel and will be sunk to the 300-ft. level where a station will be cut and a crosscut will be driven to the vein. Sinking will then be continued and levels will be opened in 150-ft. lifts. It is planned to open new ground as quickly as possible so that the output of the mine can be increased. In 1912 12,000 tons of concentrates were shipped, half of which were zinc.

H. E. M.—The richest oreshoot ever struck in the Evolution district was opened at this property near Osborn. When first struck the vein showed 6 ft. of high-grade lead-carbonate ore and since then the ore has widened to 10 ft. The oreshoot in the No. 2 tunnel had been cut off by a fault and this rich ore was found on the other side of the fault where the vein was again found. Much ore has been shipped from the upper workings lately by a leasing company. The lease has now run out and the entire mine will be operated by the mining company. Shipments will stop for the present and all work will be concentrated on the new oreshoot.

MICHIGAN

Copper

LA SALLE—A contract has been let for about ½ mile of railroad to connect with the Mineral Range tracks. Underground openings are being extended, and this property will soon be producing. The two shaft houses have been remodeled and larger hoisting equipment installed.

MASS—Operations at this property are still suspended since the shut-down about four weeks ago, owing to threatened labor troubles and no intimation has been given as to the resumption of operations, but it is probable that before this is done some remodeling will be carried out at the surface plant and also at the stamp mill.

OLD COLONY—No. 21 drill hole cut the Mayflower lode at a depth of 1621 ft., for a distance of 23 ft. and again it entered it at 1752 ft. for 25 ft., making its formation at this point about 48 ft. wide, which is about the same result as obtained in the Mayflower drilling. A fault was encountered at a depth of about 1665 feet.

OSCEOLA—The new surface equipment at No. 1 shaft of the North Kearsarge branch of this company is about completed and when it goes into commission production will be materially increased. Sinking is in progress in both No. 5 and No. 6 shafts of the man mine. At No. 6 shaft a series of electrically operated pumps at the 11, 24, 36 and 45 levels, has gone into service.

Iron

TILDEN—At this mine of the Oliver Iron Mining Co., at Bessemer, Gogebic range, No. 9 shaft was wrecked by fire May 1. The wooden shaft-house, boiler and engine house were destroyed and, due to burning of the shaft timbering, the shaft is believed to be partially caved in, as the ground was not firm. The fire started in a lagging pile. The shaft is vertical and is 650 ft. deep. Operations are now confined to shafts No. 6 and No. 10. A modern steel-lined shaft may be sunk in the future near No. 9.

CLEVELAND-CLIFFS IRON CO.—This company is reported to have made an ore strike in the Crystal Falls district, where exploration has been in progress for several months, near the finds of the Nevada Land Co. and Oliver Iron Mining Co. in the Mastadon section. The Cleveland-Cliffs Iron Co. has under option all the Sheldon Estate lands in Sec. 12, 42-33, also some land in Sec. 1, totaling over 400 acres. Test pitting and diamond drilling are in progress. The Iron County explorations of this company have not been generally successful in the past.

MONTANA

Butte District

BUTTE & ZENITH CITY—This shaft west of Butte, is 460 ft. deep and preparations are being made to cut a station. As soon as this is accomplished and a sump sunk, crosscutting will be started north and south to intersect several veins which outcrop on the surface. Much water has been encountered.

Broadwater County

REPUBLICAN—A hoist capable of sinking to a depth of 1000 ft. is being installed at this Radersburg mine. Some good ore was discovered in preliminary work on the claims and it is the owner's intention to sink 80 ft. before doing further development work.

BLACK FRIDAY—Operations have been resumed at this mine in the Radersburg district after nine months shut-down caused by litigation. The mine has been opened to the 700-ft. level where a good shoot of ore has been developed by drifting and raising. The company will sink 100 ft. deeper and drift on this ore, and also will drive a drift on the 400-ft. level. It is estimated that there is about $150,000 worth of low-grade concentrating ore on the dump, and the management is planning ways and means to raise capital to erect a concentrator.

Deer Lodge County

PYRENEES—It has been reported that this old mine in the Georgetown district has been leased under bond to

Eastern men who will open it this summer. The free-milling ore was worked out about 20 years ago and nothing has been done since to develop the base ore. W. A. Clark, and Clinton H. Moore, of Butte, are the owners.

Lewis & Clark County

EMMA—Preparations are being made to begin operations on this group of claims at Rimini. Benjamin W. Phillips and C. B. Power, of Helena, are the owners.

COPPER-SILVER MONTANA—The work of retimbering the shaft to the 300-ft. level at this property, in the Scratch Gravel hills, has been completed, and sinking to the 500-ft. level is under way. The company is installing a Sullivan compressor, and machine drills, and expects to reach the 500-ft. level within 60 days. A tunnel which is being driven to tap the shaft at a depth of 150 ft., has nearly been completed. Mining is being done on a 12-ft. vein of good copper ore.

MONTANA-YERINGTON—This mine is shipping a 50-ton car of ore to Thompson every day.

Lincoln County

A STRIKE OF RICH GALENA ore has been made on a claim, owned by H. L. Day and others, near the Big Eight mine.

BIG EIGHT—At this mine, 7 miles from Troy, extensive development work is being done. The property was purchased by Harry L. Day and others of the Federal company. The company is preparing to purchase an auto truck for hauling ore and supplies.

HOWARD PLACERS—According to information received at Libby, Charles Muffly, of Townsend, Mont., has about completed the organization of a company to work these claims, on the headwaters of Libby Creek. A large hydraulic plant, it is stated by those interested, will be installed. The placer ground is about 20 miles south of Libby, near the holdings of the Libby Placer Mining Co., operated by P. J. Brophy and other Butte men. During the last two seasons the property has been thoroughly examined. There are 840 acres in the several claims owned by the Howards and there is water in abundance. From this ground much gold has been taken in the last 50 or 60 years, this having come from the rich ground immediately along the stream on bedrock, and which was worked by hand shovel and the primitive sluice box.

Madison County

A SIDING IS BEING INSTALLED AT HARBINSON in order to shorten the haul from the mines at Silver Star to the Northern Pacific R.R. Harbinson is three miles nearer Silver Star than Iron Rod, the present shipping point.

PROSPECT—Plans are being made for the erection of a mill this summer at this mine, owned by W. H. Mallette and other Helena men. A test shipment of ore has just been sent to Helena for analysis.

HOMESTAKE—A consignment of 22 tons of ore worth about $100 per ton, was recently shipped from this property near Virginia City, to the Washoe smeltery at Anaconda. The mine is being operated on a lease.

NEVADA

Comstock Lode

UNION SHAFT—The Union and Mexican companies have withdrawn participation for the present in the operation of this shaft, Sierra Nevada paying the entire expense in order to carry on its development work on the 2500-ft. level. Union and Mexican are doing no work in their properties at present, Mexican having mined all the ore from its stopes.

COMSTOCK-PHOENIX—Arrangements have been completed to enlarge the mill in Sixmile cañon to 30 tons daily capacity. This is being done by the addition of a Kinkead crusher to the five stamps already in, and the addition of two Frue vanners and one Wilfley table to the concentrating room. Large reservoirs are being built east of the mill to impound the tailings. On the 550 level, a crosscut is being driven to the vein from which ore is now being stoped on the 400 level.

Churchill County

NEVADA WONDER MINING CO.—This gold property was equipped with a 100-ton mill and a small hoisting plant in the summer of 1911 and has been operating continuously since. By November, 1912, the developments at the mine warranted the installation of better hoisting facilities and a 70-ft. timber headframe was built and a 125-hp., double drum, electric hoist was put in place. With this additional hoisting capacity, it became necessary to enlarge the old two-compartment shaft by adding a second hoisting compartment, and to do away with the counterbalance formerly in use by putting in two double-deck cages. The mine is now operating on all levels down to the 700, where a small electric sinking hoist has been installed. Shaft sinking is in progress and the present bottom is at a point 800 ft. below the collar. It is planned to sink continuously to the 1000-ft. level and, after getting a suitable station cut there for the sinking hoist, to continue sinking to the 1500-ft. level. Development work is being carried on at the rate of 600 ft. per month. A 1200-cu.ft. Nordberg air compressor is on the road to the mine and will be set up in a few weeks, after which it is expected to increase the rate of development work. The mine is producing 115 tons per day of ore assaying from $14 to $16 per ton. The mill is operated under the Churchill Milling Co., and is milling 115 tons of ore per day. E. E. Carpenter is superintendent of the mill. J. A. Burgess superintendent of the mine.

Lyon County

RENO-YERINGTON—A hoist for the new, two-compartment shaft will be installed at once.

TRUCKEE RIVER GENERAL ELECTRIC CO.—Work will be started at once by this company to extend its lines to Pine Grove.

MASON VALLEY MINES CO.—The tonnage of ore received at the smeltery, for the week ended May 7, is as follows: From Mason Valley mine, 2577; from Nevada-Douglas, 1214; from outside mines, 807. Total, 4598 tons; daily average, 657. In the same week seven cars of matte were shipped from the smeltery.

NEVADA-DOUGLAS COPPER CO.—The sinking of the Ludwig incline shaft to the eighth level has just been completed. A station is being cut and in a short time drifting will be commenced. On the seventh level, two winzes have been sunk, one at present being 30 ft. below the sill floor of the drift, and the other 60 ft. Both of these winzes are in ore, averaging about 6% in copper. The ore encountered in these winzes is secondary, consisting principally of chalcopyrite, chalcocite, bornite and cuprite, the latter occurring in masses. Extensive development work has been carried on for the last few months in the upper levels of the Ludwig mine and a number of good oreshoots have been opened, all high grade. Development work in the south end of the mine has proved that the oreshoots extend farther south than had heretofore been anticipated. The surface at the south end of the mine shows no outcrops above the point in the levels where the recent development work has proved that rich ore exists. On the Douglas Hill part of the property, the new main tunnel, known as No. 2, driven 150 ft. below the old workings, is being used for the transportation of all ore broken in the upper levels. Large transfer chutes have been put in and the tunnel has been equipped with electric lights. New orebins of 300 tons capacity have been built at the portal of this tunnel, and the old bins formerly at the upper terminal of the tramway have been dismantled. A little later the management contemplates installing an electric-haulage system in tunnel No. 2 for more economically handling the increased tonnage from this section. Crosscuts are being driven in the lower-tunnel level to intersect the oreshoots being worked. Spot ores, which are peculiar to the Douglas Hill section, have been encountered in several places. No effort is being made to block these out until the general plan of laying out the workings has been developed. Ore of good grade is being taken from many opencuts at the surface. Many improvements have been made on the surface during recent months. A carpenter shop and framing shed has been built, equipped with timber framer, cut-off saws and other machinery for shaping mine timbers. The machine shop has been enlarged and improved and additional machinery has been installed. A new club house has been built for the men, equipped with pool and billiard tables, library, shower baths, etc. A new contract has been entered into, covering the product of the gypsum quarry and daily shipments of approximately 100 tons are now being made to the plant of the Pacific Portland Cement Co., at Reno.

Nye County

MIZPAH EXTENSION—The announcement is made that this company has been financed and development work will be started at once. A new compressor has been ordered and other new equipment will be acquired.

SHIPMENTS in tons from Tonopah mines for the week ended May 10, were as follows:

Tonopah Mining	3,200	North Star	200
Tonopah Belmont	3,405	Mizpah Extension	....
Montana-Tonopah	939	Jim Butler	350
Tonopah Extension	1,080	Tonopah Merger	54
West End	1,035		
Midway	50	Total	10,873
MacNamara	560	Estimated value	$237,891

White Pine County

GRAND PRIZE—A strike was made last winter in this mine south of Hamilton. A vein of galena was found 7 ft. wide and assaying 293 oz. of silver per ton. The mine is owned by W. B. Bierce, Donald Teasdale, and William Harwood.

DEFIANCE—Work on this property, owned by R. A. Dean, of Hamilton, was scheduled to begin as soon as the snow melted. Active work at other properties near Hamilton is anticipated for this summer, and while many seem to fear the results of a reduction of the tariff on lead, the prevailing opinion is that it will have no effect on any property that may be opened up.

NEW JERSEY

Morris County

EMPIRE STEEL & IRON CO.—The strike at the Wharton iron mines continues, the strikers having succeeded in driving the deputy sheriffs out of the town last week. The task of guarding the property has now been assigned to a private detective agency, the officers of which assured the governor that it could restore and preserve order and thus avoid the necessity of calling out troops.

NEW MEXICO

Grant County

CHINO—As regards ore reserves this is the second largest steam-shovel "porphyry" copper mine, with a developed reserve of 94,000,000 tons estimated to contain 1.81% copper. Stripping was begun in October, 1910 and 6,500,000 tons of capping has been removed. It is said that mining operations could be continued for one year without the necessity of removing more capping. A stockpile containing 500,000 tons of ore has been built up in addition to the regular requirements of mill supply. Two steam-shovel pits have been opened. One will be nearly one mile long when completed and 600 ft. wide, while the second will be nearly half a mile long and 1000 ft. wide. Two shovels are now in operation on ore and five on capping, the two shovels being sufficiently large to supply the mill. Four of the five sections of the mill are in operation, four sections treating a little more than 5000 tons of ore daily. The water supply is derived from four springs and with the present system of re-using, there is sufficient water for all present needs. For some time the management has been investigating the sources of water adjacent to the property. At a result of this work, what appears to be an excellent source of water has been found. It is about 9 miles from the mill on what is known as Lampbright Creek. Here a favorable site for a dam has been found and a survey has been made. In addition to impounding the present flow, the flood water will be stored.

Socorro County

IRON DOOR—At this property, consisting of a group of 20 claims, a cyanide plant will soon be completed. W. H. Byerts is owner.

NORTH CAROLINA

Montgomery County

UWARRA MINING CO.—The last concrete retaining wall for the new mill of this company at Candor, has been poured, and shipments of machinery from the Allis-Chalmers Manufacturing Co., have been made. Underground development shows that the two veins continue downward, being about 3 ft. wide, the ore assaying $18 per ton. Sinking of the main shaft is to be resumed using an auxiliary hoist on the 300-ft. level so that the cage to that level will not be interfered with. Percy E. Barbour is manager.

OREGON

Josephine County

PLACERS ARE CLOSING DOWN in this county owing to lack of water. Shipments of gold are being made and indications show that the output will be unusually large for the season.

JEWETT — This mine at Grants Pass is being overhauled, and will soon be ready for operation.

MICHIGAN—This mine near Murphy, which has been closed for the last four years, has been reopened, and work will continue throughout the summer.

IRON MOUNTAIN—Preparations are being made for the extensive development of this iron property near Gold Hill, owned by the Garfield Iron & Lime Co. of Portland.

UTAH

Beaver County

LEONORA—Working forces are to be increased.

ROB ROY—This property in the same district as the Sheep Rock, has started shipments.

SOUTH UTAH—Ore carrying 3% copper is reported to have been opened on the 600-ft. level west of the main workings. The mill is being operated three days per week.

SHEEP ROCK—This company's 5-stamp mill is treating 20 to 30 tons of ore daily, and it is expected to increase the capacity. A saving of 60% or more on the plates is reported. Concentrates are made and shipped.

MAJESTIC—The south drift on the 150-ft. level has cut ore. This makes four places available for stoping. Other crosscuts are to be driven for the same vein. Ten cars of copper ore, so far, have been shipped during May.

BEAVER BUTTE—At this property in the eastern part of Beaver County the shaft has been sunk to a depth of 140 ft. A station will be cut at the 150-ft. level, and drifting done on the vein. The chief valuable metal is gold.

MOSCOW—During April, 16 cars of ore amounting to about 800 tons were shipped from this property near Milford. Development work is being done in several places, and five faces of ore have been opened. New work is under way in the western part of the property, and from the showing of ore on the 300- and 400-ft. levels, this is expected to be productive ground. The property in general is in excellent condition.

CEDAR-TALISMAN—Development is being done on the fissure below the 500-ft. level, and a winze has been sunk 135 ft. Some ore has been found in the winze. The best showing ns at about 100 ft. depth. Work is being done to reach the intersection of a cross fissure with the main fissure, the objective point being about 50 ft. distant. Further development on the 100-ft. level will probably be undertaken. A car of zinc ore is being loaded by lessees.

Emery County

DRILLING FOR OIL is being done in the San Rafael Swell country west of Green River. The Desmoines well is reported to be down 1800 ft., and the Mt. Vernon, 600 ft. Gas has been found in a well east of Green River. The Utah Consolidated Land & Oil Co. is drilling in this section. A large number of oil claims have recently been filed.

Grand County

A SHIPMENT OF URANIUM-VANADIUM ore from Cisco is reported to have brought $2114 net.

Juab County

TINTIC SHIPMENTS for the week ended May 9 amounted to 175 cars.

BECK TUNNEL—A new strike has been made in old workings at a depth of 200 feet.

GOLD CHAIN—A dividend of 3c. per share, amounting to $30,000 has been declared, payable May 25. The dividend is the second for 1913. April shipments amounted to 42 cars.

Piute County

THE ALUNITE DEPOSITS near Marysvale are to be examined for English interests, it is reported.

GREENHORN—Work has been completed on the tunnel, which is now in 800 feet.

BULLY BOY & WEBSTER—It is expected that the mill will soon be ready for operation.

WEDGE—At this property near Marysville a 20-in. vein of ore, carrying free gold with some silver, has been cut. The gangue is quartz, with iron and manganese. A new shaft has been started to connect with a drift on the ore, from a winze below the main tunnel level. The strike is attracting attention.

San Juan County

SOUTHWESTERN OIL CO.—A rig is being set up to sink the first well south of San Juan River. The ground across the river from the Arcola and other wells in the vicinity of the new oil town of Mexican Hat, is regarded as favorable.

Washington County

AT FOUR PROPERTIES IN THE BULL VALLEY DISTRICT development consisting largely of tunnel work is being done. Gold is the chief valuable metal.

WASHINGTON

Ferry County

INTERNATIONAL GOLD—Preparations are being made for the development of this property in the Orient district. J. J. McCann, Spokane, is general manager.

Stevens County

CHECOP—This company has been incorporated and will develop 20 acres in the Chewelah district. J Anthony Smith and others, of Spokane, are interested.

COPPER KING—Regular shipments of ore are being made from this property to the Granby smeltery. New assay equipment has been purchased. S. P. Domer, Chewelah, is president.

LIBERTY COUNTY—Some high-grade copper ore has been struck on this property, some of which assays as high as $63 per ton. Operations are to be increased and carried on day and night during the summer. J. H. Reser, Blue Creek, is president of the company.

CANADA

British Columbia

SILVER HOARD—This company began sinking a 4x6-ft. winze from the 100- to the 200-ft. level, and as soon as the snow is off the ground, presumably about June 1, work of clearing the right-of-way for a tram to connect with the upper terminal of the Canadian Consolidated No. 1 tram, 2600 ft. distant, will be begun. The tram will have a minimum capacity of 20 tons, and will be so built that additional buckets can be added later. The aërial carrier will be installed and will be ready for operation by Aug. 1. A 10-drill water-driven air compressor plant will be begun in a few days.

Ontario-Cobalt

TIMISKAMING & HUDSON BAY—A dividend of 300%, payable May 21, has been declared.

CASEY-COBALT—The production for the week ended May 3 was 20,160 oz.; constituting a record.

PENN CANADIAN—The main shaft house has been burned. This will interrupt mining operations for some time.

COBALT TOWNSITE—The production for the week ended May 3 was 40,500 oz. A dividend of 50% has just been declared.

LA ROSE—The net profits for April were $75,404 on a production of 199,810 oz. of silver of a gross value of $126,671. The surplus, Apr. 30, was $1,652,343.

SENECA-SUPERIOR—A judgment against this company has been given in favor of W Blackie, of Cobalt, for $1848 and costs, as commission for the sale of 260,000 shares of the capital stock of the company.

McKINLEY-DARRAGH-SAVAGE—The addition to the mill has been completed and the company will soon be in a position to treat 100 tons of ore per day from the Savage dumps. The ore is being transported by an aërial tramway and there is three years' supply of milling ore on the Savage dump. The production for April was 171,028 ounces.

SHIPMENTS of ore and concentrates in tons, for Cobalt for the week ended May 17 were as follows:

Bailey	.....	La Rose	42.89
Beaver	.....	Lost and Found	.....
Buffalo	32.95	McKinley-Darragh	151.68
Casey Cobalt	.....	Nipissing	63.57
Chambers-Ferland	.....	Nipissing Reduction	.....
City of Cobalt	.....	O'Brien	32.46
Cobalt Lake	31.84	Penn.-Canadian	25.45
Cobalt Townsite	40.86	Provincial	.....
Colonial	.....	Right of Way	.....
Coniagas	.....	Seneca Superior	.....
Crown Reserve	.....	Silver Bar	.....
Dominion Reduction Co.	42.00	Silver Queen	.....
Drummond	.....	Timiskaming	.....
General Mines	.....	Trethewey	.....
Green Meehan	.....	Wettlaufer	.....
Hargraves	.....	York	20.00
Hudson Bay	.....		
Kerr Lake	30.14	Total	513.84

Ontario-Porcupine

FOSTER—These mines, formerly known as the Foster-Tough-Oakes property, consist of six claims of an area of 220 acres. Two of the claims are in Teck and four in Lebel township, all adjoining. Active mining was started Nov. 15, 1912, and shipments of high-grade ore have been made as follows: Shipment A, sample lot from outcrop of five veins, weighed 2 tons, assaying gold, 18.6 oz.; silver, 22.7 oz. Shipment B, 20 tons, assaying gold, 22.5 oz.; silver, 34.6 oz. Shipment C, 21 tons, assaying gold, 19.27 oz.; silver, 30.61 oz. shipment D, 30 tons, assaying gold, 24 oz.; silver, 35 oz. All of this ore, with the exception of the last shipment, was taken from an underhand stope on the No. 2 vein. The last shipment was from a development shaft on this vein. This shaft is now 115 ft. deep and a station is being cut at the 100-ft. level. Shipments of high-grade ore will be continued during the year. The main high-grade vein averages 12 in. in width and the milling ore in the foot wall and hanging wall, has a total width of 20 ft. This milling ore contains approximately 1 oz. gold and 6 to 10 oz. silver per ton. The veins occur in both the Timaskaming series of the Lower Huronian and the gray porphyry. The fissures are from 450 to 900 ft. long and show high-grade ore continuously along the outcrop. The first unit of the milling plant consists of 5 stamps inside and plate amalgamation only being used to recover the gold. A scheme of complete treatment will be worked out with this unit and a larger mill will probably be built during the year. The first unit went into commission about May 1. The power plant consists of two 40-hp. locomotive boilers and a 300-cu.ft. straight-line air compressor. Drilling is done with B. C. 26 Rand sinkers, using 1-in. hexagonal hollow steel. Three 8-hr. shifts are worked in the shaft and the 100-ft. level was reached four weeks after the work was started. Wood is used for fuel and costs $2 per cord at the boilers. The operations have been profitable from the commencement of active mining.

THE MARKET REPORT

METAL MARKETS

NEW YORK—May 21

Rather more firmness has characterized most of the metals. Last week's break in tin was quite severe and has not yet been recovered.

Copper, Tin, Lead and Zinc

Copper—The market of this week was decidedly dull. There have appeared to be concerted efforts to depress the London speculative market, bearish operations emanating in part from this side. The larger agencies here have continued to ask for electrolytic 15⅞@15¾c., delivered, usual terms, but the lower price has been shaded materially by some of the small sellers and second-hands, who have taken most of the business offered. Sales have been reported at 15.70c., delivered in Europe and at 15.67½c., delivered in Connecticut. A few transactions in Lake copper were reported, but quotations for this kind are mainly nominal. On the whole, buyers appear inclined to await developments before committing themselves to new contracts, and for the moment business is almost at a standstill. The market for casting copper seems to be demoralized. It is reported that there were sales of goodsized quantities of this material at less than the current quotations. The close is easy at 15¾@15⅞c. for Lake copper and 15.45@15.55c. for electrolytic copper in cakes, wirebars and ingots. Casting copper is quoted nominally at 15.20@15.30c. as an average for the week.

The standard market has been under pressure throughout the week, but so far bear selling has met with a considerable degree of resistance. The close is undecided at £68 16s. 3d. for spot, and £68 10s. for three months.

Visible stocks of copper in Europe May 15 are reported as follows: Great Britain, 21,180; France, 4020; Rotterdam, 5700; Hamburg, 4590; Bremen, 2170; total, 37,660 long tons, or 84,358,500 lb. This is a decrease of 710 tons from the Apr. 30 report. In addition to the stocks given 1850 tons are reported afloat from Chile and 3200 from Australia, making a total of 42,710 tons.

Base price of copper sheets is 21@22c. per lb. Full extras are charged, and higher prices for small quantities. Copper wire is 16½c. carload lots at mill.

Copper exports from New York for the week were 8180 long tons. Our special correspondent gives the exports from Baltimore at 1899 tons for the week.

Tin—The London market fluctuated considerably, but mainly in a downward direction. Heavy sales on the part of one of the leading operators in tin, who recently was very active on the bull side, but has now again turned a bear, were responsible for the severe decline. This operator's attitude is ascribed to the rather poor trade reports from this side and the consequent lack of orders and a deterioration of the statistics. It is to be noted that spot tin suffered mostly from the decline, while three months' material was not so seriously affected, so that the backwardation today amounts to only about £4 or £5.

At the lower level of prices, consumers are showing more interest and business is being done now at prices very close to the importation basis. The market closes firmer at £220 10s. for spot, and £215 5s. for three months, and 48¼c. in New York.

Shipments of tin from the Straits four months ended Apr. 30, corrected report, were 18,830 long tons in 1912, and 19,730 tons in 1913; increase, 1100 tons.

Tin production of Federated Malay States four months ended Apr. 30 was 15,540 long tons in 1912, and 14,864 tons in 1913; decrease, 676 tons.

Lead—Business has been rather quiet. Quotations remain unchanged, but there seems to be a slightly softer tone. We quote 4.20@4.25c., St. Louis, and 4.30@4.35c., New York.

The London market is very strong, due to the conditions in Mexico, from where it is reported that practically all the lead smelters have been compelled to stop operations either on account of traffic interruptions or because they have not been able to get supplies of fuel, coke, etc. The close is firm at £19 7s. 6d. for Spanish lead, and 7s. 6d. higher for English.

In its fiscal year ending Apr. 30, 1913, the St. Joseph Lead Co. produced and sold 66,847 tons of lead, at an average of 4.35c. per lb., St. Louis. The quotational average, as reported in the "Journal," for the same period was 4.387c.

Spelter—Business has been rather quiet, but at last there appears to be some speculative interest at the present level, as evidenced by inquiries for future deliveries, which producers are not inclined to satisfy freely. Spelter for nearby deliveries is in ample supply. Sales have been made at 5.25c., St. Louis basis. Some small sales for delivery in June and July are reported at 5.30c. Spelter for near-by shipment has been freely offered at 5.25c. We quote the market at 5.25@5.30c., St. Louis, and 5.40@5.45c., New York.

The London market is again lower, and the close is cabled at £24 10s. for good ordinaries and £25 17s. 6d. for specials.

Base price of zinc sheets has declined to $7.50 per 100 lb. f.o.b. La Salle-Peru, Ill., less 8% discount.

DAILY PRICES OF METALS

NEW YORK

May	Sterling Exchange	Silver	Copper		Tin	Lead		Zinc	
			Lake, Cts. per lb.	Electrolytic, Cts. per lb.	Cts. per lb.	New York, Cts. per lb.	St. Louis, Cts. per lb.	New York, Cts. per lb.	St. Louis, Cts. per lb.
15	4.8635	61	15⅝ @15⅝	15.50 @15.60	48¼	4.30 @4.35	4.20 @4.25	5.40 @5.45	5.25 @5.30
16	4.8625	60⅞	15⅝ @15⅝	15.45 @15.55	48¼	4.30 @4.35	4.20 @4.25	5.40 @5 45	5.25 @5.30
17	4.8630	60¾	15⅝ @15⅝	15.45 @15.55	48¼	4.30 @4.35	4.20 @4.25	5.40 @5.45	5.25 @5.30
19	4.8645	60⅞	15⅝ @15⅝	15.45 @15.55	48¼	4.30 @4.35	4.20 @4.25	5 40 @5.45	5.25 @5.30
20	4.8645	60⅞	15⅝ @15⅝	15.45 @15.55	47¾	4.30 @4.35	4.20 @4.25	5.40 @5.45	5.25 @5.30
21	4.8645	60⅞	15⅝ @15⅝	15.45 @15.55	48¼	4.30 @4.35	4.20 @4.25	5.40 @5.45	5 25 @5.30

The quotations herein given are our appraisal of the market for copper, lead spelter and tin based on wholesale contracts with consumers without distinction as to deliveries; and represent, to the best of our judgement, the bulk of the transactions, reduced to basis of New York, cash, except where St. Louis is specified as the basing point. The quotations for electrolytic copper are for cakes, ingots and wirebars. The price of electrolytic cathodes is usually 0.05 to 0.10c. below that of electrolytic. We quote casting copper at 0.15c. below the price for electrolytic. The quotations for lead represent wholesale transactions in open market for good ordinary brands, both desilverized and non-desilverized; the specially refined corroding lead commands a premium. The quotations on spelter are for ordinary Western brands; special brands command a premium. Silver quotations are in cents per troy ounce of fine silver.

LONDON

May	Silver	Copper			Tin		Lead, Spanish	Zinc, Ordinaries
		Spot	3 Mos	Best Sel'td	Spot	3 Mos		
15	28⅛	68⅝	68 11/16	75	221	214¼	18½	25
16	28 1/16	69¼	69 1/16	75½	224	218	18½	24½
17	28	....	....	....	....	....	....	....
19	28 1/16	68¾	68⅝	74½	219¾	214	18⅝	24½
20	28 1/16	68 1/16	68⅝	74½	218½	213½	19 1/16	24½
21	27 15/16	68 13/16	68½	75	220½	215½	19⅛	24½

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb. ,except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for best selected, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices, in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given: £10 = 2.17½c.; £15 = 3.26c. = £25 = 5.44c.; £70 = 15.22c. Variations, £1 = 0.21¾c.

Other Metals

Quicksilver—Stocks are light and prices have been slightly advanced. New York price is $40 per flask of 75 lb., with 59c. per lb. for small lots. San Francisco, $38.50 for domestic orders, and $36 for export. The London price is £7 10s. per flask, with £7 1s. named from second hands.

Antimony—The market is very dull, as no forward buying is being done, since everyone is waiting for the change of duty. We quote: Cookson's, 8.75@9c. per lb.; Hallett's 8.25@8.50c., and 7.70@7.90c. for Chinese, Hungarian, and other outside brands.

Bismuth—The syndicate which controls the European production quotes 7s. 6d.—equal to $1.80—per lb. in London. In New York a quotation of $1.72 per lb. is made for metal produced from American ores.

Aluminum—The market remains rather quiet, with very little doing except on contract business. Quotations are unchanged at 26½@26¾c. per lb. for No. 1 ingots, New York. The foreign market is steady.

Cadmium—The latest quotation from Germany is 725@750 marks per 100 kg. f.o.b. works in Silesia. This is equal to 78.27@80.97c. per lb. at works.

Gold, Silver and Platinum

Gold—There was no change on the open market in London, prices remaining at 77s. 9d. per oz. for bars and 76s. 4d. per oz. for American coin. Most of the supplies went to the Bank of England.

Gold exports from New York for the week ended May 24 were $4,038,366, nearly all to Paris; imports were $336,836, chiefly from Mexico and Central America.

Silver—The market has ruled quiet and steady the past week with small fluctuations pending the offering of the Chinese loan on May 20, and closes lower at 27 1/16 d. in London on selling by Chinese banks.

Exports of silver from London to the East, Jan 1 to May 8, reported by Messrs. Pixley & Abell:

	1912	1913	Changes	
India	£2,576,300	£2,682,300	I.	£106,000
China	630,000	216,000	D.	414,000
Total	£3,206,300	£2,898,300	D.	£308,000

Exports of silver from New York week ended May 17 were $401,750, chiefly to London; imports were $107,311, largely from South America.

Iridium—No increased supply has developed and the market continues strong. Dealers ask about $85 per oz., New York.

Platinum—Trade is rather quiet, but steady, and prices are firm Dealers ask $45@46 per oz for refined platinum, while hard metal is $49@52 per oz,, according to percentage of iridium.

Our Russian correspondent writes under date of May 8 that the St. Petersburg market is still strong and prices are practically unchanged. Some new companies with large capitalization are being formed for prospecting on and working platinum deposits. Two or three new dredges will shortly commence working in the North Ural. Great activity is reported from Ekaterinburg. Quotations are: Ekaterinburg, 9.70@9.73 rubles per zolotnik; St. Petersburg, 37,700@37,800 rubles per pood for crude metal, 83% platinum, equivalent to $36.47@36.58 and $36.97@37.07 per oz., respectively.

Zinc and Lead Ore Markets

PLATTEVILLE, WIS.—May 17

The base price paid this week for 60% zinc ore was $40 to 43 per ton. The base price paid for 80% lead ore was $52 to 53 per ton.

SHIPMENTS WEEK ENDED MAY 10

	Zinc ore, lb.	Lead ore, lb.	Sulphur ore, lb.
Week	2,009,980	144,290	2,038,960
Year to date	54,485,980	2,719,720	25,146,570

Shipped during week to separating plants, 2,098,410 lb. zinc ore.

JOPLIN, MO.—May 17

The high price of blende is $47, the base per ton of 60% zinc ranging from $42@46, for ore under 4% iron, and as high as $48 base for ore carrying higher in iron. Calamine sold on a base of $20@22 per ton of 40% zinc. The average of all grades of zinc is $41.96 per ton. Lead is unchanged at $52.50 per ton of 80% metal contents. The average of all grades is $52 per ton.

SHIPMENTS WEEK ENDED MAY 17

	Blende	Calamine	Lead ore	Value
Totals this week.	12,750,720	592,850	1,475,070	$315,024
20 weeks	218,364,990	14,575,280	37,222,050	6,223,773

Blende value, the week, $269,805; 20 weeks, $5,047,586.
Calamine value, the week $6851; 20 weeks, $196,285.
Lead value, the week, $38,365; 20 weeks, $979,902.

IRON TRADE REVIEW

NEW YORK—May 21

Little change is to be noted in the finished-steel market since our last report. More new business is coming in some lines, such as bars and sheets, but structural steel is rather quiet. There is much work in prospect in structural lines, but it does not seem to be quite ready for contract.

A turn in the pig-iron market seems imminent, the first symptom being a number of inquiries for basic and foundry pig. It is quite generally understood that stocks in consumers' yards are generally low, and that new supplies must be had before long. The recent tendency of the pig-iron market has been to move spasmodically, and it looks as if a rush of buying was nearly due.

Sentiment in the steel trade has grown still more unfavorable. Producers are much impressed by the completeness with which new buying has been shut off, and appear to derive little comfort from the fact that specifications are fair and buyers are eagerly taking material as fast as made, the rate of production being practically at the record. Apparently the end is clearly in sight, the only question being whether it will be weeks or months before production will have to be curtailed and prices of finished-steel products will suffer, for under present conditions steel manufacturers would not think for a moment of undertaking any form of artificial price control to sustain the market.

In trade circles the common remark is that conditions are absolutely unique, when mills are able to operate at full capacity on material which is going into actual consumption and yet pessimism is universal, with continued declines in scrap and pig iron. Predictions as to the future are made with diffidence, and cover a wide variety of ideas. The tariff, at first given the entire blame for the change in conditions, is now variously regarded, many in the steel trade holding that its harmful influence is chiefly sentimental, through tending to depress business generally, and that the contemplated reductions will neither bring much material into this country nor force material reductions in prices. As most observers expect prices to fall eventually from other causes this view meets with some favor.

PITTSBURGH—May 20

Prices of rails, bars, plates and structural shapes are strictly maintained. In wire products and merchant pipe there is occasional, though slight, shading. In tin plate it appears one or two mills are cutting prices, but only slightly, while in sheets there is shading by several mills.

Pig Iron—It begins to look as if the Westinghouse Electric & Manufacturing Co., which inquired for its second-half pig iron a fortnight ago, might not buy at this time after all. The company evidently expected to make a purchase at bottom price and see the market gain strength afterwards, but now the question is when bottom will be reached, since some early quotations made against the inquiry have been reduced. The trade has been looking to the Westinghouse transaction to establish a market and the delay has produced a particularly dull market. Prices are quotably lower by 50c. on all grades except bessemer, which is entirely inactive, but the reduced figures here given are hardly the market, there being no definite market and the quotations merely representing what it is known pig iron could be bought for: Bessemer, $17; basic, $15; malleable, $14.50; No. 2 foundry, forge, $14, all f.o.b. Valley furnace, 90c. higher, delivered Pittsburgh.

Connellsville Coke—The market is claimed by sellers to be somewhat firmer, but in the absence of important transactions it is difficult to see whence the strength could have come. We quote: Prompt furnace, $2.15@2.25; contract furnace (nominal asking price), $2.50; prompt foundry, $2.85@3.25; contract foundry, $3@3.25 per ton at ovens.

Ferromanganese—The contract market is stagnant, while cutting from the recognized figure is general on small lots.

We quote prompt at $60@60.50, and contract at $61, Baltimore, freight to Pittsburgh being $2.16, according to the new schedule, which became effective May 13.

Steel—The market has weakened all around, by at least $1 per ton from our previous quotations, $28.50 for prompt billets and $27 for third-quarter billets, while mills will begin deliveries earlier on sales made at the forward price, so that there is really little of a prompt market. A sale of 500 tons of sheet bars has been made for immediate delivery on the basis of less than $27 at maker's mill, though possibly this transaction could not be duplicated. On forward business mills have quoted $27 on sheet bars and solicited counter offers. Prices named refer particularly to openhearth steel. Bessemer is more difficult to secure than openhearth, reversing the experience of last winter. We quote: Prompt billets, $27.50; prompt sheet bars, $28; forward billets, $26.50; forward sheet bars, $27, f.o.b. maker's mill, Pittsburgh or Youngstown.

Sheets—The sheet market is being shaded by two or three mills on both black and galvanized, the extreme shading being $2 per ton. Such cases are not common, occurring only in certain districts, but are sufficient to show that the market is far from strong. With most mills specifications are almost equal to current shipments, which are practically at record rate, and there is an accumulation of specifications which will carry most of the mills for several months even with new specifications coming in at the present reduced rate. New business is extremely light. We quote, subject to occasional shading: Blue annealed, 10-gage, $1.75c.; black, 28-gage, 2.35c.; galvanized, 28-gage, 3.40@3.50c.; painted corrugated, 2.55c.; galvanized corrugated, 3.50@3.55c. per pound.

Foreign Trade of the German Empire in iron and steel and manufactures thereof, three months ended Mar. 31, metric tons:

	Exports		Imports	
	1912	1913	1912	1913
Iron and steel	1,428,482	1,604,595	163,760	151,520
Machinery	117,410	129,624	18,548	15,947
Totals	1,545,892	1,734,219	182,308	167,467

Increase in exports this year, 188,327 tons; decrease in imports, 14,841 tons.

IRON ORE

Of the Lake Superior shipments in April only 262,047 tons, or 30.2% were delivered to Lake Erie ports.

Stocks of ore on Lake Erie docks, May 1, are reported at 5,706,477 tons, against 5,881,245 tons on May 1, 1912. The stocks on Dec. 1 last were 9,497,166 tons, so that the winter movement to furnaces from Lake Erie docks was 3,790,691 tons.

The East Texas Brown Ore Co. is developing its property near Marshall, Tex., and will soon be in a position to ship. The ore will be hauled over the Santa Fé R.R. to Galveston, about 300 miles, and shipped thence by steamer. An ore dock has been built at Galveston. It is understood that contracts have been made with eastern furnaces to ship an ore running 55% iron, 0.09% or under in phosphorus, with a trace of sulphur and high in silicon.

Imports of iron ore into Great Britain four months ended Apr. 30 were 1,865,447 long tons in 1912, and 2,738,934 in 1913; increase, 873,487 tons.

SAULT CANAL TRAFFIC

Traffic movement through the Sault Canal in April was active. The American canal opened Apr. 18 and the Canadian canal Apr. 14. The freight carried in the 12 days was: East bound, 1,098,123; west bound, 807,432; total, 1,905,055 short tons. The number of vessel passages was 582, showing an average cargo of 3273 tons. The mineral freights included were 729,196 tons coal; 292,918 tons iron ore; 28,237 tons pig and manufactured iron; 1053 tons copper; 6957 bbl. salt. In April, 1912, the tonnage was only 166,918 tons, owing to the late opening of navigation.

COKE

The New Jersey Zinc Co. is in the market for 120,000 tons Connellsville coke, to be delivered at Hazard, Penn., at the rate of 10,000 tons per month.

German Exports of Fuel, three months ended Mar. 31, were 8,460,214 metric tons coal; 19,730 tons brown coal; 1,698,747 tons coke; 875,593 tons briquettes; total, 11,754,274 tons, an increase of 1,476,549 tons over last year. Imports were 2,177,843 tons coal; 1,732,519 tons brown coal; 139,996 tons coke; 41,924 tons briquettes; **total, 4,090,282 tons**, an increase over 1911 of 138,705 tons.

CHEMICALS

NEW YORK—May 21

The general chemical market is dull.

Arsenic—Prices have again softened, in anticipation of large receipts toward the end of the month. Quotations are $3.62½@3.75 per cwt. in carload lots.

Copper Sulphate—There is no change in the quoted price of $5.25 per cwt. for carload lots and $5.50 for smaller parcels.

Nitrate of Soda—The market is quiet. Quotations are 2.60c. per lb. for spot, 2.57½c. for May, 2.55c. for June, 2.50c. for July and August, and 2.47½c. for later deliveries.

COPPER SMELTERS' REPORTS

This table is compiled from reports received from the respective companies, except in the few cases noted (by asterisk) as estimated, together with the reports of the U. S. Dept. of Commerce as to imported material, and in the main represents the crude copper content of blister copper, in pounds. In those cases where the copper contents of ore and matte are reported, the copper yield ther is reckoned at 97%. In computing the total American supply duplications are excluded.

	Jan.	Feb.	March	April
Alaska shipments	1,668,328	660,250	472,293	1,730,252
Anaconda	21,000,000	21,250,000	22,900,000	23,800,000
Arizona, Ltd.	3,100,000	3,000,000	3,200,000	3,100,000
Copper Queen	7,554,966	6,810,706	7,558,709	8,210,166
Calumet & Arizona	4,750,000	4,050,000	4,250,000	4,500,000
Chino	3,298,030	3,898,998	4,464,723	.....
Detroit	1,769,071	1,689,277	1,640,671	1,856,517
East Butte	1,469,000	1,325,000	1,400,000	.....
Mammoth	1,957,804	1,661,150	1,641,091	1,450,000
Giroux	650,000	*600,000	*625,000	.....
Mason Valley	1,655,319	1,348,070	1,608,492	.....
Nevada Con.	4,169,705	4,798,537	5,555,320	.....
Ohio	492,760	380,849	596,651	.....
Old Dominion	2,727,000	2,381,000	2,853,000	3,040,000
Ray	3,610,000	3,610,000	4,287,400	.....
Shannon	1,232,000	1,152,000	1,260,000	1,238,000
South Utah	*ni.*	*ni.*	*nil*	.....
United Verde*	2,900,000	2,750,000	3,000,000	.....
Utah Copper Co.	7,333,495	7,585,303	8,248,880	9,539,847
Lake Superior*	17,500,000	19,000,000	19,000,000	.....
Non-rep. mines*	7,500,000	7,000,000	8,000,000	.....
Total production	96,337,478	94,950,141	102,562,230	.....
Imports, bars, etc.	34,026,236	21,372,292	.....	.....
Total blister	130,363,714	116,318,433	.....	.....
Imp. in ore and matte	7,563,758	9,459,432	.....	.....
Total American	137,927,472	125,781,865	.....	.....
Miami†	2,932,369	2,817,200	3,102,200	2,312,900
Shattuck-Arizona	1,381,422	1,136,480	1,234,450	1,158,326
Brit. Col. Cos.:				
British Col. Copper	720,260	688,312	844,735	794,000
Granby	1,792,245	1,740,000	1,967,962	1,857,452
Mexican Cos.:				
Boleo†	2,658,880	2,535,680	2,204,720	2,811,200
Cananea	5,450,000	4,880,000	4,772,000	3,581,690
Moctezuma	2,913,294	2,730,914	3,062,159	2,753,240
Other Foreign:				
Braden, Chile	1,484,000	1,178,000	1,472,000	1,512,000
Cape Cop., S. Africa	770,540	.....	732,480	.....
Kyshtim, Russia	1,644,160	1,352,960	.....	.....
Spassky, Russia	974,400	1,003,520	974,400	.....
Exports from				
Chile	6,752,000	5,824,000	7,840,000	7,616,000
Australia	9,744,000	5,512,000	6,944,000	6,608,000
Arrivals in Europe ‡	17,689,280	8,509,760	15,585,920	10,545,920

† Boleo copper does not come to American refiners. Miami copper goes to Cananea for treatment, and reappears in imports of blister.
‡ Does not include the arrivals from the United States, Australia or Chile.

STATISTICS OF COPPER

	United States			Visible Stocks.		
Month	U.S.Refin'y Production	Deliveries, Domestic	Deliveries, for Export	United States	Europe	Total
IV, '12.	125,464,644	69,513,846	53,252,326	62,367,557	136,819,200	199,186,757
V.	126,737,836	72,702,277	69,485,945	695,066,02	134,176,000	199,242,029
VI.	122,315,240	66,146,229	61,449,650	49,615,643	117,801,600	167,417,244
VII.	137,161,129	71,094,381	60,121,331	44,335,004	108,186,000	152,521,003
VIII.	145,628,521	78,722,418	70,485,150	50,280,421	113,299,200	163,579,621
IX.	140,089,819	63,460,810	60,264,796	46,701,374	113,568,000	160,269,374
X.	145,405,453	84,104,734	47,621,342	63,065,587	107,408,000	170,473,587
XI.	134,695,400	69,369,795	55,906,550	76,744,964	103,801,600	180,546,564
XII.	143,354,042	58,491,723	65,713,796	86,164,059	96,947,200	183,111,259
Year, 1912	1,581,920,287	819,665,948	746,396,452	.....	.....	.....
I. 1913.	143,479,625	65,210,030	60,383,845	105,312,582	78,491,840	183,904,422
II.	130,948,881	59,676,492	72,168,523	123,198,332	77,504,000	200,702,332
III.	136,251,849	76,585,471	77,699,306	122,302,890	81,244,800	203,547,690
IV.	135,353,402	78,158,837	85,894,727	104,269,270	87,180,800	191,450,070
V.	.....	.....	.....	75,549,108	85,948,800	161,497,908

Note—From Jan. 1, 1913, visible supplies in Europe do not include copper afloat.

Assessments

Company	Delinq	Sale	Amt.
Algomah, Mich.	June 16	.....	$1.00
Best & Belcher, Nev.	May 20	June 10	0.05
Big Indian Copper, Utah.	May 13	June 4	0.018
Blue Star, Ida.	May 10	June 17	0.04
Booth	May 19	June 23	0.02
Bullion, Ida.	May 3	May 31	0.005
Busy Bee, Utah.	May 10	June 5	0.0025
Cœur d'Alene Vulcan, Ida.	May 17	June 2	0.01
Con. Imperial, Nev.	May 6	May 28	0.01
Deer Trail, Utah	May 8	June 6	0.005
East Cœur d'Alene, Ida.	May 9	June 2	0.002
Field Gold Copper, Utah.	May 13	June 4	0.015
Hale & Norcross, Nev.	May 5	May 26	0.05
North Lake, Mich.	May 19	.....	1.00
Overman, Nev.	May 28	June 18	0.05
Sandstorm Kendall, Nev.	May 12	June 16	0.01
Santaquin Central, Utah.	Apr. 21	May 31	0.005
Seven Troughs Mon., Nev.	May 10	June 7	0.0025
Shasta Copper Exp., Calif.	May 28	June 16	0.025
Trade Dollar Ext., Utah.	May 29	June 17	0.005
Union Con., Nev.	May 14	June 4	0.10
United Copper, Mont.	May 15	.....	0.30
Utah Centennial, Utah.	May 15	June 2	0.002
Utah Mine, Utah.	June 7	June 26	0.05

Monthly Average Prices of Metals

SILVER

Month	New York			London		
	1911	1912	1913	1911	1912	1913
January	53.795	56.260	62.938	24.865	25.887	28.983
February	52.222	59.043	61.642	24.081	27.190	28.357
March	52.745	58.375	57.870	24.324	26.875	26.669
April	53.325	59.207	59.490	24.595	27.284	27.416
May	53.308	60.880	.....	24.583	28.038	.....
June	53.043	61.290	.....	24.486	28.215	.....
July	52.630	60.654	.....	24.286	27.919	.....
August	52.171	61.606	.....	24.082	28.375	.....
September	52.440	63.078	.....	24.209	29.088	.....
October	53.340	63.471	.....	24.594	29.299	.....
November	55.719	62.792	.....	25.649	29.012	.....
December	54.905	63.365	.....	25.349	29.320	.....
Year	53.304	60.835	.....	24.592	28.042	.....

New York quotations, cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

	New York				London, Standard	
	Electrolytic		Lake			
	1912	1913	1912	1913	1912	1913
January	14.094	16.488	14.337	16.767	62.760	71.741
February	14.084	14.971	14.329	15.253	62.893	65.519
March	14.698	14.713	14.868	14.930	65.884	65.329
April	15.741	15.291	15.930	15.565	70.294	68.111
May	16.031	.....	16.245	.....	72.352	.....
June	17.234	.....	17.443	.....	78.259	.....
July	17.190	.....	17.353	.....	76.636	.....
August	17.498	.....	17.644	.....	78.670	.....
September	17.508	.....	17.698	.....	78.762	.....
October	17.314	.....	17.661	.....	76.389	.....
November	17.326	.....	17.617	.....	76.890	.....
December	17.376	.....	17.600	.....	75.516	.....
Year	16.341	.....	16.560	.....	72.942	.....

New York, cents per pound, London, pounds sterling per long ton of standard copper.

TIN

Month	New York		London	
	1912	1913	1912	1913
January	42.529	50.298	191.519	238.273
February	42.962	48.766	195.036	220.150
March	42.577	46.832	192.619	213.645
April	43.923	49.115	200.513	224.119
May	46.063	.....	208.830	.....
June	45.815	.....	205.863	.....
July	44.519	.....	202.446	.....
August	45.857	.....	208.351	.....
September	49.135	.....	223.762	.....
October	50.077	.....	228.353	.....
November	49.891	.....	227.619	.....
December	49.815	.....	226.875	.....
Av. year	46.096	.....	209.322	.....

New York in cents per pound; London in pounds sterling per long ton.

LEAD

Month	New York		St. Louis		London	
	1912	1913	1912	1913	1912	1913
January	4.435	4.321	4.327	4.171	15.597	17.114
February	4.026	4.325	3.946	4.175	15.738	16.550
March	4.073	4.327	4.046	4.177	15.997	15.977
April	4.200	4.381	4.118	4.242	16.331	17.597
May	4.194	.....	4.072	.....	16.509	.....
June	4.392	.....	4.321	.....	17.588	.....
July	4.720	.....	4.603	.....	18.544	.....
August	4.569	.....	4.452	.....	19.655	.....
September	5.048	.....	4.924	.....	22.292	.....
October	5.071	.....	4.894	.....	20.630	.....
November	4.615	.....	4.463	.....	18.193	.....
December	4.303	.....	4.152	.....	18.069	.....
Year	4.471	.....	4.360	.....	17.929	.....

New York and St. Louis cents per pound. London, pounds sterling per long ton.

SPELTER

Month	New York		St. Louis		London	
	1912	1913	1912	1913	1912	1913
January	6.442	6.931	6.292	6.854	26.642	26.114
February	6.499	6.239	6.349	6.089	26.661	25.338
March	6.626	6.078	6.476	5.926	26.048	24.605
April	6.633	5.641	6.483	5.491	25.644	25.313
May	6.679	.....	6.529	.....	25.790	.....
June	6.877	.....	6.727	.....	25.763	.....
July	7.116	.....	6.966	.....	26.174	.....
August	7.028	.....	6.878	.....	26.443	.....
September	7.454	.....	7.313	.....	27.048	.....
October	7.426	.....	7.276	.....	27.543	.....
November	7.371	.....	7.221	.....	26.804	.....
December	7.162	.....	7.081	.....	26.494	.....
Year	6.943	.....	6.799	.....	26.421	.....

New York and St. Louis, cents per pound. London, pounds sterling per long ton.

PIG IRON IN PITTSBURG

	Bessemer		Basic		No. 2 Foundry	
	1912	1913	1912	1913	1912	1913
January	$15.12	$18.15	$13.32	$17.35	$14.00	$18.59
February	15.03	18.15	13.28	17.22	14.01	18.13
March	14.95	18.15	13.66	16.96	14.10	17.53
April	15.13	17.90	13.90	16.71	14.15	16.40
May	15.14	.....	13.90	.....	14.12	.....
June	15.15	.....	14.11	.....	14.22	.....
July	15.15	.....	14.38	.....	14.38	.....
August	15.43	.....	14.90	.....	14.85	.....
September	16.86	.....	16.03	.....	15.63	.....
October	17.90	.....	17.18	.....	17.22	.....
November	18.07	.....	17.09	.....	18.00	.....
December	18.15	.....	17.45	.....	18.73	.....
Year	$16.01	.....	$14.93	.....	$15.28	.....

STOCK QUOTATIONS

COLO. SPRINGS May 20

Name of Comp.	Bid.
Acacia	.02½
Cripple Cr'k Con.	.01½
C. K. & N.	.13½
Doctor Jack Pot.	.07
Elkton Con.	.56½
El Paso	3.85
Findlay	.02½
Gold Dollar	.10½
Gold Sovereign	‡ 02½
Isabella	.10½
Jack Pot	.05½
Jennie Sample	‡.03½
Lexington	‡ 008
Moon Anchor	‡.01
Old Gold	.02½
Mary McKinney	.58
Pharmacist	.01½
Portland	.98
Vindicator	.92
Work	‡.004

SALT LAKE May 20

Name of Comp.	Bid.
Beck Tunnel	.06
Black Jack	.10
Cedar Talisman	.01½
Colorado Mining	.13½
Columbus Con.	‡ 06
Crown Point	‡ 02½
Daly-Judge	5.50
Grand Central	61
Iron Blossom	1.32½
Little Bell	‡.35
Lower Mammoth	.04
Mason Valley	4.00
May Day	.10
Nevada Hills	.58
New York	‡ 03
Prince Con	.40
Silver King Coal'n	3.90
Sioux Con.	.02
Uncle Sam	.05
Yankee	.05

TORONTO May 20

Name of Comp.	Bid	Name of Comp.	Bid
Bailey	.09½	Foley O'Brien	.27
Coniagas	.07½	Hollinger	17.50
T. & Hudson Bay	‡64.00	Imperial	.03
Timiskaming	.34	Jupiter	.45½
Wettlaufer-Lor.	.12	Pearl Lake	.53
Apex	‡.02½	Porcu. Gold	.17
Crown Chartered	.00½	Preston E. D.	‡.04
Dobie	‡.15	Rea	.20
Dome	‡17.50	Swastika	.07
Dome Exten.	.08	West Dome	‡ 34½

SAN FRANCISCO May 20

Name of Comp.	Clg.	Name of Comp.	Bid
COMSTOCK STOCKS		MISC. NEV. & CAL.	
Alta	.05	Belmont	6.25
Belcher	.19	Jim Butler	.89
Best & Belcher	.05	MacNamara	.16
Caledonia	.84	Midway	.44
Challenge Con.	.04	Mont.-Tonopah	1.60
Chollar	.03	North Star	.65
Confidence	.20	West End Con.	1.12½
Con. Virginia	.11	Atlanta	.15
Crown Point	.21	Booth	.04
Gould & Curry	.02	C.O.D. Con.	.04
Hale & Norcross	.16	Comb. Frac.	.04
Mexican	.67	Jumbo Extension	.23
Occidental	.70	Pitts.-Silver Peak	.50
Ophir	.11	Silver Pick	.05
Overman	.25	St. Ives	‡.30
Potosi	.03	Tramp Con.	.02
Savage	.08	Argonaut	‡1.55
Sierra Nevada	.07	Bunker Hill	‡1.00
Union Con.	.09	Central Eureka	.15
Yellow Jacket	.20	So. Eureka	‡2.75

N. Y. EXCH. May 20

Name of Comp.	Clg.
Amalgamated	74⅛
Am. Agri. Chem.	48
Am.Sm.&Ref.,com	67¼
Am. Sm. & Ref., pf.	102⅛
Am. Sm. Sec., pf. B	82⅞
Anaconda	37¾
Batopilas Min.	1⅛
BethlehemSteelpf	71
Chino	38⅞
Federal M. & S., pf.	35
Goldfield Con.	2
GreatNor.,ore,ctf.	34½
Guggen. Exp.	46¾
Homestake	100½
Inspiration Con.	17⅛
Miami Copper	23
Nat'nalLead,com.	47
National Lead, pf.	105½
Nev. Consol.	16½
Phelps Dodge	200
Pittsburg Coal, pf.	81⅛
Ray Con.	18
Republic I&S,com.	23½
Republic I & S, pf.	81½
SlossSheffi'd,com.	31
Sloss Sheffield, pf.	88
Tennessee Copper	34⅝
Utah Copper	50¾
U. S. Steel, com	60½
U. S. Steel, pf.	105⅞
Va.Car. Chem., pf.	99

N. Y. CURB May 20

Name of Comp.	Clg.
Barnes King	1.20
Beaver Con.	.35
Braden Copper	7⅝
B. C. Copper	3
Buffalo Mines	2¼
Caledonia	‡.40
Con. Ariz. Sm.	⅛
Davis-Daly	2 1/16
Diam'field-Daisy	.04
Ely Con.	.06
Florence	.46
Giroux	2
Gold Hill Con.	‡¼
Greene Cananea	6⅜
Greenwater	.05
Internat. S. & R.	‡113
Kerr Lake	3 1/16
Keystone	‡2
La Rose	2⅜
McKinley-Dar-Sa.	1⅞
Min. Co. of A. new	2¾
Motherlode Gold.	‡.60
Nev. Utah M. & S.	‡.01
Nipissing Mines	8⅞
Ohio Copper	⅜
Pacific Sm. & M.	⅛
Puebla S. & R.	2⅛
South Live Oak	‡2
South Utah M. & S.	1/16
Standard Oil (Old)	‡1030
Stand'd Oil of N.J.	360
Stewart	1 1/16
Tonopah	5⅛
Tonopah Ex.	2⅛
Tonopah Merger	.83
Tri-Bullion	1/16
Tularosa	⅛
Union Mines	⅛
United Cop., pfd.	‡6
Yukon Gold	2 1/16

BOSTON EXCH. May 20

Name of Comp.	Clg.
Adventure	2
Ahmeek	295
Algomah	.15
Allouez	33
Am. Zinc	23
Ariz. Com., ctfs.	3
Bonanza	.35
Boston & Corbin	1¼
Butte & Balak	‡2⅛
Calumet & Ariz.	63¾
Calumet & Hecla	455
Centennial	12½
Cliff	1½
Copper Range	43
Daly West	2½
East Butte	11¾
Franklin	5¼
Granby	63
Hancock	18½
Hedley Gold	32
Helvetia	¼
Indiana	9½
Island Cr'k, com.	47
Island Cr'k, pfd.	81⅞
Isle Royale	22⅛
Keweenaw	1¼
Lake	12
La Salle	4¼
Mass	3½
Michigan	1½
Mohawk	50
New Arcadian	1½
New Idria Quick.	3⅜
North Butte	29
North Lake	1¾
Ojibway	1
Old Dominion	47
Osceola	83
Quincy	63
Shannon	8¾
Shattuck-Ariz.	24
Superior	27
Superior & Bost.	3
Tamarack	28
Trinity	3¾
Tuolumne	2⅛
U. S. Smelting	3 1/16
U. S. Smelt'g, pf.	46¾
Utah Apex	1⅝
Utah Con.	7⅛
Victoria	1
Winona	1¾
Wolverine	51½
Wyandot	¾

BOSTON CURB May 20

Name of Comp.	Last
Alaska Gold M.	10⅜
Bingham Mines	3⅛
Boston Ely	⅜
Boswycolo	‡.01
Butte Central	1 1/16
Cactus	.07
Calaveras	2⅞
Chief Cons	1½
Corbin	.90
Cortez	.30
Crown Reserve	3⅜
Eagle & Blue Bell	.98
First Nat. Cop.	1⅞
Majestic	38
Mexican Metals	.68
Moneta Porc.	‡.06
Nevada-Douglas	1⅞
New Baltic	.85
Oneco	⅜
Raven Copper	.07
Rhode Island Coal	.03
Smokey Dev.	1½
S. W. Miami	2
South Lake	5½
Trethewey	.40
United Verde Ext.	.68

LONDON May 20

Name of Com.	Clg.
Camp Bird	£0 19s 0d
El Oro	0 15 0
Esperanza	1 6 3
Mexico Mines	‡5 12 3
Oriental Con.	‡1 8 4
Oroville	0 6 9
Santa Gert'dis	1 3 9
Tomboy	1 5 0

‡Last quotation.